SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JULY 1911.

GENERAL PHYSICS.

818. *Silver Disc Pyrheliometer.* **C. G. Abbot.** (Smithsonian Miscellaneous Collections, 56. 19. pp. 1–10, March 31, 1911.)—The recording portion of this instrument consists of a silver disc bored out to admit the cylindrical bulb of a sensitive thermometer. To allow of more perfect heat conduction to the bulb the cavity is lined with steel and the intervening space filled with mercury. The aperture is hermetically sealed with a shellaced cord and Chatterton wax. The tube of the thermometer is shielded and protected by a long nickeled brass tube, a slot being provided for reading the scale. The scale is graduated from − 15° C. to + 50° C. in tenths of a degree. The silver disc is enclosed in a cylindrical copper box, which again is enclosed in a wooden cover to minimise temperature-changes. The admission of sunlight is controlled by three diaphragms, and the whole interior of the copper cover is thickly coated with lampblack. The instrument is mounted on a simple equatorial stand with screw and worm-wheel for following the sun. It is not intended that this pyrheliometer should be employed for absolute determinations of the solar constant. Its purpose is merely to furnish readings proportional to the intensity of the sun's radiation, comparable with one another at all times and places. To secure such measurements at widely separated stations instruments of this pattern have been sent to Rykatchew at St. Petersburg, Violle at Paris, and Chistoni in Italy. Instructions for setting up and working are also given. C. P. B.

819. *Method of determining Upper and Lower Elastic Limits, and the Hardening of Metals.* **O. Faust** and **G. Tammann.** (Zeitschr. Phys. Chem. 75. 1. pp. 108–126, Nov. 1, 1910.)—It is possible, by microscopic observation of the polished surface of a metal block, to determine accurately to 1 per cent. the point of permanent deformation in tension or compression; this point being the same for both. Most metals show isolated crystals or conglomerations when the lower elastic limit is passed; at higher loads planes of cleavage follow. In copper this order is reversed; the elastic limit rises with a rising load and, with extremely slow increase of load, the highest working stress used becomes the lower elastic limit of the metal. Thus the metal hardens up, till the upper elastic limit—the point of elastic flow—is reached. The hardening (or recovery) of a metal is determined quantitatively by the values of the two elastic limits. This recovery is caused, not by the formation of a hard crystalline structure or by a change to the amorphous state, but by diminution of size of the constituent crystals caused by the formation of different planes of cleavage. The pressure on each crystal is considerably diminished by the increase of the number in a given volume, and, since the total friction is independent of the rubbing area, the elastic limit rises till it reaches the point of flow, where so many systems of cleavage planes have been formed that cleavage can take place. Thus the hardening serves as a process preparatory for elastic flow. This theory of the raising of the lower elastic limit is supported by the following facts: (*a*) The microscope shows that hardening is accompanied by the formation of smaller crystals. (*b*) Quick cooling of the metal during crystallisation has the same effect on the number of crystals and on the elastic limit. (*c*) A fluid pressure causing a stress beyond the upper limit causes no cleavage surfaces in the metal and does not affect the lower limit. (*d*) The hardness of the individual crystals, determined with the sclerometer, is not sensibly altered during the elastic hardening. C. A. M. S.

820. *Application of Some Modern Methods of Testing to Copper Alloys.* **L. Révillon.** (Bull. Soc. d'Encouragement, 115. pp. 862–872, March, 1911.)—Some of the modern methods of testing worked out for the study of steels have been applied to copper alloys. Preliminary experiments indicated that they only serve to show the diminution of the quality of the metal as a result of the presence of cavities, blowholes, oxides, and other impurities, but the researches have been continued with a view to placing on record the value of, and the relation between the various tests. Sixty-two samples of copper and its alloys (bronzes, simple and complex brasses) containing from 60 to 99·8 per cent. Cu have been subjected to tensile, Brinell hardness, Frémont shear, and Guillery shock tests, both as drawn and after annealing at 650° C. Overheated metal breaks with a heterogeneous coarsely crystalline fracture, and shows little elongation and no reduction of area in the tensile test. Unlike overheated steel it cannot be restored by mechanical treatment, but has to be re-melted. The figures for the elastic limit and elongation afford an idea of the initial hardening of the material. If R is the tensile strength and Δ the Brinell hardness of the material, $R = c\Delta$ gives the relation between the two properties, c being equal to 0·88 for hard-drawn and 0·51 for annealed material. This only holds for sound material, R/Δ diminishing as the metal becomes unsound. The author concludes that the application of these methods to the study of the copper alloys gives a more complete insight into their useful properties. F. C. A. H. L.

821. *Mechanism of the Permanent Deformation of Stretched Metals.* **L. Hartmann.** (Comptes Rendus, 152. pp. 1005–1007, April 10, and pp. 1084–1086, April 24, 1911.)—The results are given of tests on the extension of moderately thin bars. Two stages are evident in the process of elongation. When the elastic limit is passed the constituent parts of the material are unequally affected. In tempered steel, polished and annealed, the film of oxide caused by heating exhibits sharp irruptions forming remarkably regular

four-sided pyramids, of various sizes, all alike and arranged symmetrically. In plan their diagonals are parallel and perpendicular respectively to the axis of the specimen, and they intersect the surface in lozenges, whose greater axes lie transversely and whose sides thus make an angle "*a*" with the axis, greater than 45° and generally about 60°. The number of pyramids increases very rapidly with the load. The number continues to increase for a time after the load is left stationary, this effect being the more pronounced when elongation has been rapid before stopping the load. Finally, when the load is sufficiently high, the whole surface is broken into pyramids whose bases, being contiguous, form dark or brilliant lines, according to the method of illumination adopted. At this moment the pyramids abut most frequently along lines at angle "*a*" with the axis. This first stage extends to the neighbourhood of the ultimate load. It is followed by the appearance of strictures or grooves extending from one edge of the bar to the other; they represent aggregations of juxtaposed molecular deformations and are inclined to the axis at the angle "*a*." Normal to their general direction they take the form of waves with double inflection which stand out from the surface by varying amounts. According to the nature of the metal, fracture occurs either (*a*) by the accentuation of one wave or of two neighbouring waves till the specimen breaks in one groove or between the two waves, or (*b*) the initial strictures are not very deep and no one grows more quickly than the others. In this case the increasing load causes a series of waves of molecular displacements to travel over the metal which serrate the entire surface and are followed by a second series cutting up the granulations left by the first. Finally rupture takes place, and in the large stricture which forms at this instant can be seen a series of lines which are the traces of the last series of molecular undulations.

In the second paper some tests on annealed brass bars ½ mm. thick by 20 mm. wide are described. The elastic limit, at 90 kg. load, is indicated by the sudden appearance of sinuous depressions following the two general directions at angle "*a*" to the axis. When the load reaches 160 kg. the surface becomes entirely granulated and the directions of the lines are not perceptible. The surface is now repolished, and an increase of a few kg. gives rise to a remarkably clear and regular network of lines. An increase to 220 kg. obliterates these lines, which reappear, after repolishing, under a slow increase of load. This process may be repeated until rupture occurs. It is found that polishing one face only of the specimen causes the growth of a concavity in the other face which, in the brass bars above, exceeded 1 mm. in depth. The suggested explanation is that the molecular movement is less at the axis than at the surface, so that the removal by polishing of the surface metal on one side accentuates the inequality on the unpolished side, the latter assuming a concave surface. Tests were made on bars 20 mm. wide having notches in the sides opposite each other and spaced at regular intervals of 20 mm. from each other. Depressions appeared, all of which started from the notches and were inclined at the angle "*a*" to the axis. It should be noted that no contractions appear joining the notches, as the reduced area in these directions would lead one to expect. If the notches are arranged zigzag fashion along the edges, depressions are formed in two regular systems which are independent of each other, and which form lozenges whose greater axes are perpendicular to the axis of the specimen. A circular hole in the centre of the specimen becomes the centre of systems of lines forming the arms of a cross inclined at an angle "*a*" to the axis.

C. A. M. S.

822. *Brownian Movement of Particles due to very Rapid Air-waves.* **S. Lifschitz.** (Comptes Rendus, 152. pp. 761–762, March 20, 1911.)—When a Leyden jar is discharged and the spark is oscillatory air vibrations of very short wave-length are set up. These waves produce Brownian movements of particles of smoke. Such movements were studied with an ultramicroscope. At the moment of the discharge displacements of all the particles of smoke occur, but the directions of the displacements are very various. The displacement is greater the greater the energy of the discharge. The frequency of the oscillations varied between 25×10^4 and 50×10^4 per sec. A. R.

823. *The Function of the Walls in Capillary Phenomena.* **S. L. Bigelow** and **F. W. Hunter.** (Journ. Phys. Chem. 15. pp. 367–380, April, 1911.)—The authors have determined the height to which water and benzene rise when the liquid surface is in contact with materials of different kinds. The method employed was a modification of that used many years ago by Oersted. On the ground end of a glass tube was placed a plate of the particular material, in which a fine hole had been drilled. The tube was depressed in the liquid, the capillary ascent of which was to be determined and was then raised until the liquid broke away from the capillary opening in the plate. The values of radius of opening multiplied by height of ascent in the case of water and benzene are given in the following tables:—

WATER: Temp. 20·5 — 21°.

Material used.	Value of *rh*.		
	Highest.	Lowest.	Average.
Zinc	15·28	14·98	15·15
Copper	15·32	15·08	15·11
Nickel	15·12	14·89	15·00
Aluminium	15·04	14·63	14·78
Silver	14·89	14·61	14·75
Platinum	14·76	14·69	14·72
Glass	14·71	14·68	14·69
Celluloid	14·29	13·97	14·12
Bees'-wax	13·08	12·98	13·02
Paraffin	9·90	9·43	9·69

BENZENE: Temp. 20·5 ± 0·2°.

	Value of *rh*.
Silver	6·16
Nickel	6·11
Aluminium	6·07
Copper	6·02
Platinum	6·01
Glass	5·87

It is thus shown that, according to the above measurements, the capillary ascent varies with the nature of the capillary tube. This is explained by the author as due to differences in adhesion between the liquid and the substance of the wall. A. F.

824. *Dependence of the Coefficient of Transmission of the Atmosphere on Meteorological Conditions.* **O. v. Myrbach-Rheinfeld.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 419–485, March, 1910.)—Regular measurements of solar radiation were made with an Ångstrom pyrheliometer at Innsbruck, from Jan. 4 to June 30, 1908, from which the value of the coefficient of transmission was determined for each day. The author finds a more intimate connection to exist between transmissibility and vapour pressure than had been observed by other investigators. He finds a mean decrease of transparency per mm. of vapour pressure over the range from $e = 8$ mm. to $e = 12$ mm. of 0·009 (Westmann 0·005, Gorczinski 0·006). The connection with the atmospheric pressure is considerable. The transparency decreases on the average by 0·004 for a decrease of pressure of 1 mm. The observations were also grouped according to barometric distribution. The transparency was found greatest under anticyclonic conditions, other distributions following in the order (2) wedge of "high" projecting from the East (Föhn conditions), (3) uniform pressure distribution, (4) wedge of "high" projecting from West, (5) "col" between two "highs." The transparency was thus found to be greatest under conditions of descending air, and least under conditions of ascending air currents. A schedule of the daily observations is appended to the paper. R. G. K. L.

825. *Seiches in Windermere.* **G. Dobson.** (Nature, 86. pp. 278–279, April 27, 1911.)—Islands and shallow water near the middle of the lake divide Windermere into a deep upper half and a less deep lower half. Both have seiches of their own, but there is also a common uninodal seiche of the whole lake, of small amplitude and long period, 69·7 min. The author made observations at two spots, and describes the simple form of recording limnograph which he used; it is made with a float of 5 in. diameter, while Chrystal's wagon recorder requires a float of 10 in. H. B.

826. *Solar Constant of Radiation.* **C. G. Abbot** and **F. E. Fowle, Jr.** (Astrophys. Journ. 33. pp. 191–196, April, 1911.)—In a paper published in 1909 [Abstract No. 1365 (1909)] details were given of an attempt to fix the true pyrheliometric scale for the reduction of radiation observations made at the Smithsonian Astrophysical Observatory, and attention was called to the necessity of determinations further in the ultra-violet than had been customary. Both these questions have now received attention. Observations with apparatus specially adapted for ultra-violet investigation have been made on Mount Wilson and Mount Whitney in California. The individual values for Mount Wilson during the period 1905–09 are reproduced as curves showing the detailed variations, indicating a solar variability with a range of 8 per cent. The agreement of results at different altitudes does not indicate an atmospheric origin for the fluctuations. The final result is that the mean value of the solar constant of radiation is 1·922 cals. per cm.^{2} per minute. C. P. B.

827. *Periodicity of Sun-spots.* **A. Schuster.** (Roy. Soc., Proc. Ser. A. 85. pp. 50–53, March 14, 1911.)—Taking the mean areas of sun-spots from the Greenwich measures it is found that there is a well-marked period of 4·79 years, and a similar period has been found by Oppenheim for magnetic declination. Attention is drawn to the 33-years' periodicity shown by sun-spots and the Leonide meteors. C. P. B.

828. *Temperature of the Sun.* **F. Kurlbaum.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 25. pp. 541–554, 1911.)—By spectroscopic comparison of sunlight with a standard lamp a series of determinations of the solar temperature have been made. The mean result is given as 5780° abs. (Holborn-Day scale) or 6890° abs. (Holborn-Valentiner scale). C. P. B.

829. *Comet Photometry.* **H. K. Shaw.** (Roy. Astronom. Soc., M.N. 71. pp. 232-238, Jan., 1911.)—To determine the magnitude of a faint comet it is proposed to count over an area of the plate (covering about one-third of a square degree) the number of stars which are apparently as bright as the comet, and by comparison with the Groningen Catalogue the limiting magnitude of the stars is deduced. If the stars have trailed during the exposure on the comet a correction must be introduced to allow for this. A discussion is given of the chief errors to which the method is liable. C. P. B.

830. *Selective Absorption of the Atmosphere.* **C. Galissot.** (Comptes Rendus, 152. pp. 569–571, March 6, 1911.)—An attempt has been made to determine the coefficients of atmospheric selective absorption on starlight at the Lyons Observatory, using three-colour screens according to the method proposed by Nordmann. The measurements of brightness were made at various positions from 4° to 88° zenith distance. From the results of a preliminary discussion it appears that diffraction effects are operative to a considerable extent. C. P. B.

831. *Equatorial Current of Jupiter in* 1880. **A. S. Williams.** (Roy. Astronom. Soc., M.N. 71. pp. 145–156, Dec., 1910.)—From observations of eight spots the rotation period of the equatorial current of Jupiter during the opposition of 1880-81 was 9h. 50m. 7·62s. This is nearly 20 sec. shorter than the value during the twenty years 1888–1908, being equivalent to a real difference of velocity of about 15 miles (24 km.) per hour. C. P. B.

832. *Leverrier's Theory of Motion of Jupiter and Saturn.* **R. T. A. Innes.** (South African Journ. Sci. pp. 104–120, Jan., 1911.)—Leverrier's theory and the tables based on it constituted the authority for places of Jupiter until the publication of Hill's revised values, now used in the English, American, and German Ephemerides. A comparison of the places according to Leverrier, Hill, and recent photographs obtained at Greenwich, shows that Hill's tables represent the longitude of Jupiter in 1908–09 within 2″, while Leverrier's error is about 18″. The discrepancy is shown to be in a great part due to Leverrier's adoption of an erroneous value for the ratio of the mean distances of Jupiter and Saturn, this being one of the fundamental criteria of his theory, and therefore vitiating with full weight all dependent derivatives. C. P. B.

833. *Dark Band surrounding Polar Caps of Mars.* **E. M. Antoniadi.** (Roy. Astronom. Soc., M.N. 71. pp. 144–145, Dec., 1910.)—The writer briefly reviews the photographic evidence bearing on the relative brightness of the Martian polar caps and the general continental areas, showing that even on the best images taken at Mount Wilson there is no trace of the dark band which has been described by many observers from visual results only. C. P. B.

834. *Radiation Pressure applied to Cosmic Problems.* **A. F. and F. A. Lindemann.** (Roy. Astronom. Soc., M.N. 71. pp. 156–161, Dec., 1910.)—

Starting with the deduction from the electromagnetic theory of light that two black bodies repel each other with a force involving their dimensions, absolute temperature, and distance apart, the analysis is extended to cases where the bodies have a definite albedo, to particles in space without intrinsic heat, and to the planets with varying conditions of density, temperature, and albedo. He finds that two stones of albedo 0·3 and density 3 will neither attract nor repel each other when they are at the same distance from the sun as the earth if the product of their radii is 9·5 cm.^{2}, or if of equal size, if their diameters are 6·16 cm. If they are smaller they will repel each other, if larger they will attract each other. It is also shown that within the planetary system only particles the product of whose density and radius, in cm.^{2}, is greater than 0·3 can attract one another; this result, of course, not being applicable to the case of cosmical dust so fine that the diam. of the particles becomes comparable with the wave-length of the radiation pressing them apart. Some interesting applications to comets are included, showing that in some cases the method may furnish values of the mass of the body. A suggestion is given that some cometary orbits may be oval instead of elliptical, and that this may account for the observed delay of perihelion.
C. P. B.

835. *Absorption and Diffusion of Light by Meteorites.* **Salet.** (Comptes Rendus, 152. pp. 994–995, April 10, 1911.)—Various statisticians have computed the number of stars of certain magnitudes which on theories of distribution should be visible, and to explain the variations of these estimates from the actual numbers as counted on photographs of the sky several elaborate theories have been formulated. The author suggests that part at least of the effect may be due to the absorption and diffusion of starlight by the myriads of meteorites distributed in space. C. P. B.

836. *Interference Spectra of Nebulæ.* **C. Fabry** and **H. Buisson.** (Comptes Rendus, 152, pp. 995–997, April 10, 1911. Astrophys. Journ. 33. pp. 406–409, June, 1911.)—Interferometer determinations are especially suitable for the examination of light sources emitting only a few monochromatic radiations, and this being one of the chief characteristics of gaseous nebulæ, the authors have made several interesting experiments in this way. With the 26-cm. objective of the Marseilles Observatory observations were made on the nebula of Orion. By visual examination the interference rings were seen without difficulty, with differences of path of 0·6 mm., 2 mm., and 5 mm., due to the principal nebular radiation at λ5007. Photographs were also taken with 0·6 mm. difference of path and exposures of 30 and 15 minutes, showing perfectly sharp rings. It is hoped that the method will lead to more accurate wave-lengths of the nebular spectrum lines, and probably of the radial velocity of the nebulæ themselves. C. P. B.

837. *Spectrum of Red Star in Lacerta.* **T. E. Espin.** (Roy. Astronom. Soc., M.N. 71. pp. 189–190, Jan., 1911.)—On Dec. 30, 1911, a red star was detected in Lacerta, 0m. 7·5s. following BD. + 51° 3420, and about 2 minutes of arc south of it. Spectroscopic examination showed the presence of bright lines. First seen in twilight as 8·0 magnitude, it showed the H_β line of hydrogen very bright, flanked on the more refrangible side by an enormous band making the spectrum discontinuous. Another bright band was then visible, and still further to the violet another suspected. One bright line was in the yellow, and between this and H_β three bands with bright flutings between them. [This object is now catalogued as Nova Lacertæ.] C. P. B.

838. *Proper Motion of Small Star near 17 Lyræ.* **S. W. Burnham.** (Roy. Astronom. Soc., MN. 71. pp. 208–218, Jan., 1911.)—Previous attention has been called to the remarkable proper motion of a small star near 17 Lyræ [Abstract No. 1061 (1908)] ; although only of the eleventh magnitude it shows a proper motion of 1·752″ in position angle 49·5°. C. P. B.

839. *Intrinsic Light and Effective Temperatures of Algol System.* **C. Nordmann.** (Bull. Astronomique, 27. pp. 145–152, May, 1911. Nature, 86. p. 292, April 27, 1911. Abstract.)—By a method involving the knowledge of the intrinsic light and effective temperature of the sun, it is attempted to determine these quantities for the variable Algol and its assumed satellite. The result indicates that the surface brightness of Algol is about 26 times that of the sun per unit area, and its effective temperature about 18,800°. C. P. B.

840. *Variation of Light of S Aræ.* **A. W. Roberts.** (Astrophys. Journ. 33. pp. 197–216, April, 1911.)—The light curve of S Aræ appears to indicate that the variability is compound, one part being due to intrinsic light-change, the other due to eclipsing by variation of orbital positions with respect to the sun. The period as determined at Lovedale, South Africa, is 10h. 50m. 48·45s., found from the instants when the variable passes through the tenth magnitude during its increasing phases. A long list of observations is recorded, covering the period April 1 to September 22, 1910. C. P. B.

REFERENCES.

841. *Calculating Machine.* **K. Hoecken.** (Zeitschr. Instrumentenk. 31. pp. 101–105, April, 1911.)—Describes, with diagrams, photograph, and theory, an apparatus designed for various arithmetical and trigonometrical calculations, including the calculation of hyperbolic functions. The apparatus is simple, easy to use, and mechanically good. A. W.

842. *Stop-watch with Electrically-operated Release and Stop.* **H. Lux.** (Zeitschr. Instrumentenk., Beib. 6. pp. 57–60, March 15, 1911.)—Illustrated.

843. *Palmer Physical Laboratory of Princeton University.* **H. McClenahan.** (Science, 32. pp. 289–295, Sept. 2, 1910.)—The chief feature consists in the ventilating equipment, by which either complete or partial artificial ventilation can be obtained, and any desired humidity (for electrostatic studies, &c.). Refrigeration and constant-temperature rooms with thermostatic temperature control are other special features, and the provision of pressure and vacuum piping to all parts. L. H. W.

844. *Elasticity on Relativity Principle.* **W. v. Ignatowsky.** (Phys. Zeitschr. 12. pp. 164–169, March 1, 1911.)—A mathematical discussion of the theory of elasticity from the standpoint of the relativity principle. The author concludes that Barus' claim to define the rigid body "as one in which a volume element does not change in the resting state" must be conceded. [See Abstract No. 32 (1911).] E. H. B.

845. *Simplification of Formulæ for Ferro-concrete Beams with Single Reinforcement.* **W. C. Unwin.** (Engineering, 91. pp. 267–268, March 3, 1911.

846. *Milling Cutters and their Efficiency.* **A. L. DeLeeuw.** (Amer. Soc. Mech. Engin., Journ. 33. pp. 449–482, April, 1911.)

847. *Propagation of Shearing Deformation in Gases.* **R. Reiger.** (Ann. d. Physik, 34. 2. pp. 258–276, Feb. 8, 1911.)

848. *Maxwell's Law of Velocity Distribution on the Relativity Theory.* **F. Jüttner.** (Ann. d. Physik, 34. 5. pp. 856–882, May 9, 1911.)—A mathematical examination of the velocity distribution on Planck's theory and the principle of relativity. It is concluded that the law of equipartition of energy in ideal monatomic gases is never strictly satisfied on the relativity theory. [See Abstract No. 1014 (1906).] E. H. B.

849. *Common Sense of Relativity.* **N. Campbell.** (Phil. Mag. 21. pp. 502–517, April, 1911.)—A descriptive examination of the principle of relativity intended to make it easily grasped by the "man in the laboratory." E. H. B.

850. *Motions in Continuous Media.* **K. Żorawski.** (Acad. Sci. Cracovie, Bull. 3a. pp. 175–192, March, and 4a. pp. 193–218, April, 1911.)—Highly analytical and unsuitable for brief abstraction. E. H. B.

851. *Relativity Principle, and Representation of the Physical Effects in Four-dimensional Space.* **P. Frank.** (Zeitschr. Phys. Chem. 74. 4. pp. 466–495, 1910.)

852. *Motion of Elongated Projectiles around their Centre of Gravity.* **de Sparre.** (Annal. Soc. Sci. de Bruxelles, 35. 2. pp. 79–150, 1910–1911.)—A theoretical paper.

853. *Uniform Motion of a Sphere through a Viscous Fluid.* **H. Lamb.** (Phil. Mag. 21. pp. 112–121, Jan., 1911.)—Mathematical.

854. *The Weight of a Falling Drop and the Laws of Tate.* III. *Apparatus for Determination of the Weight of a Falling Drop.* **J. L. R. Morgan.** (Amer. Chem. Soc., Journ. 33. pp. 349–362, March, 1911.)—The paper describes in detail an apparatus for determining surface tension by the drop method. A. F.

855. *Coefficient of Compressibility of Liquids.* **W. A. Suchodski.** (Zeitschr. Phys. Chem. 74. 3. pp. 257–276, 1910.)—A new method for measuring the compressibility of a liquid has been worked out by the author. For details the original must be consulted, where a large amount of numerical detail is recorded. F. J. B.

856. *Planes of Closest Fit to Systems of Points.* **E. C. Snow.** (Phil. Mag. 21. pp. 367–386, March, 1911.)—A mathematical proof is given of various theorems arising from Pearson's papers on the theory of the lines and planes of closest fit to systems of points. Practical applications of the theorems to experimental results are also given. A. R.

857. *Hydrodynamical Notes.* **Rayleigh.** (Phil. Mag. 21. pp. 177–195, Feb., 1911.)—Potential and Kinetic Energies of Wave Motion.—Waves moving into Shallower Water.—Concentrated initial Disturbance with inclusion of Capillarity.—Periodic Waves in Deep Water advancing without change of Type.—Tide Races.—Rotational Fluid Motion in a Corner.—Steady Motion in a Corner of Viscous Fluid.

858. *Note on a Gravitational Problem.* **C. V. Burton.** (Phys. Soc., Proc. 22. pp. 67–72, May, 1910.)—The problem considered is based upon the supposition that the action of gravity is intermittent in character.

LIGHT.

859. *Monochromator.* **H. du Bois** and **G. J. Elias.** (Zeitschr. Instrumentenk. 31. pp. 79–87, March, 1911. Communication from the Bosscha Laborat.)—Describes a spectrum apparatus of high dispersion which can also be used to give strong monochromatic light for polarimetric measurements. The apparatus is of the fixed-arm type, the light from the collimator passing first through a fixed 30° prism, then through a 60° prism, and after reflection from a mirror through a second 60° prism and another of 30° which is also fixed. The two 60° prisms and the mirror are all turned by the same micrometer screw so that minimum deviation is always secured. For details the original paper must be consulted. [See also Abstracts Nos. 1000 (1904) 1858 (1906), and 462 (1911).] A. W.

860. *Double Refraction of Caoutchouc produced by Stretching, and its Subsequent Elasticity.* **P. Rossi.** (N. Cimento, 20. pp. 268–277, Oct., 1910.)—Continuing his work on the subject [Abstract No. 1705 (1910)] and with the same samples of caoutchouc, the author has compared the ordinary and extraordinary refractive indices with the elastic properties during prolonged subjection to constant stretching force. The behaviour of vulcanised and non-vulcanised rubber is practically identical, Poisson's ratio, which for non-vulcanised rubber is about half that for vulcanised rubber, remaining constant, and the double refraction diminishing during tension, so that the ratio $(n_e - n_o)/(P/s)$ also remains almost constant. W. H. Sɪ.

861. *Speed of Light in Refracting Media.* **Gutton.** (Comptes Rendus, 152. pp. 1089–1091, April 24, 1911.)—A previous note described a method of comparing the speeds of electric waves and of light in air [see Abstract No. 781 (1911)]. The author now gives the result of using the same apparatus for comparing the speeds of light in air and in a liquid. The liquids used were carbon disulphide and monobromonaphthalene. The results obtained are in accord with the theory developed by Gouy in his memoir on the propagation of light in dispersive media. E. H. B.

862. *Refraction and Dispersion of Light in the Gases CO_2, CO, and C_3O_2.* **G. Gruschke.** (Ann. d. Physik, 34. 4. pp. 801–816, April 7, 1911. Extract of Dissertation, Breslau, 1910.)—Measures of refractive index for several different wave-lengths in each of the gases named are tabulated, together with results obtained by previous observers in the case of CO_2 and CO. These gases were analysed, and the results of the analysis used to correct the indexes. The optical qualities of C_3O_2 have previously only been investigated for the liquid state. The author's results for C_3O_2 are not entirely satisfactory, revealing the existence of a systematic error. Natanson's hypothetical relation between dispersion and valency does not derive much support from the observed results, which diverge considerably from those computed by his formula [see Abstract No. 1205 (1909)]. A. E.

863. *Optical Dispersion: Analysis of its Dependence upon Physical Conditions.* **T. H. Havelock.** (Roy. Soc., Proc. Ser. A. 84. pp. 492–523, Jan. 26, 1911.)—

The chief results are summarised by the author in the following manner: (1) The formal scheme of the theory is the representation of the effect of the physical state of the medium upon its dispersion by means of two variables: the density ρ, and a quantity σ expressing an effect of surrounding molecules. (2) A relation independent of σ is deduced, and is used as a test of the theory, namely, the difference of $\rho/(n^2-1)$ for any two physical states is independent of the wave-length. (3) As the result of an analysis of available experimental data, it appears that the scheme is sufficiently adequate for gases, for liquids, and for changes of state from gas to liquid. For solid substances, the two variables ρ and σ are not sufficient to express all the facts, but it seems that the term involving σ must at least be taken into account in a complete theory. (4) It is shown that it is possible to include, either wholly or in part, the dispersion of artificial or natural double refraction in simple cases. (5) By assigning a standard state for the medium, gas at 0° and 760 mm., for which σ is zero, numerical values of σ are obtained for various substances in different states. Anomalies in molecular refractivity are ascribed, in part, to the variations in σ. (6) Using a type of dispersion formula involving ρ and σ, it is shown that the positions of the absorption maxima depend upon these quantities as well as upon the frequencies of the natural vibrations of the molecule. The consequent displacement of the maxima for varying conditions of pressure, temperature and density are illustrated by analysing certain experimental data. L. H. W.

864. *Dispersive Power of Prism Combinations. Application to Spectroscopes.* **G. Meslin.** (Journ. de Physique, 1. Ser. 5. pp. 88–104, Feb., and pp. 208–218, March, 1911.)—Many spectroscopes are constructed so that the dispersion can be varied according to the number of prisms interposed in the path of the rays of light. In many such apparatus the dispersive power is doubled by doubling the number of interposed elements, but this rule of proportion is far from holding generally; in some cases indeed the dispersion is actually diminished by the interposition of an additional member. The author discusses various cases of prism combinations, and derives formulæ for calculating the dispersive power applicable also to systems including gratings or echelons. When two combinations are superposed, the order of disposition is not immaterial. The problems treated are simplified by considering the equivalence of a simple prism possessing certain of the properties of the compound system, and having the same dispersive power, while others of its properties are at the disposal of the calculator. If A denotes the prism-angle, n the index, i and e angles of incidence and emergence, the dispersion of a compound prism of two members is—

$$\frac{\sin A_2}{\cos e_2 \cos r_2}\, dn_2 \pm \frac{\cos i_2 \cos r'_2}{\cos e_2 \cos r_2}\, \frac{\sin A_1}{\cos e_1 \cos r_1}\, dn_1.$$

The dispersion of a single prism would be $(\sin A\, dn)/(\cos e \cos r)$. Equating these two expressions gives another relation connecting the quantities involved, in addition to the fundamental relations. If a compound prism be reversed end for end, the new dispersive power Δ' is connected with the old, Δ, and the magnifying power M, by the equation $\Delta' = \Delta/M$, M being equal to the continued product of the quantities de/di for all the prisms of the combination. The paper concludes with a discussion of the magnifying power of a compound prism, in the course of which it is shown that when the incidence varies the magnifying power always varies in the same direction. A. E.

865. *Opacity of Certain Glasses for the Ultra-violet.* **L. Bell.** (Amer. Acad., Proc. 46. No. 24. pp. 671–680, April, 1911.)—The glasses investigated include a few optical glasses and several coloured glasses commonly used for protective spectacles in America. Previous studies of the subject from the ophthalmological side have mostly been made with open electric arcs subject to fluctuations. The author used a quartz mercury lamp operating at 200 volts, with a current of 4 amps., and a concave-grating spectrograph. The results are illustrated by spectrograms of the region from 410–310 μμ; also by a spectrogram of the extreme ultra-violet portion of the quartz lamp spectrum, from 310–230 μμ, which is relatively rich in lines, but is obliterated by the absorption of all the glasses examined. At 230 μμ atmospheric absorption becomes very powerful. The "abiotic" radiations, which are particularly active in cell destruction, are indicated in the last spectrogram. The bactericidal effects are practically confined to wave-lengths less than 270, and increase beyond this point with enormous rapidity, an effect possibly corresponding to the powerful ionisation produced in this part of the extreme ultra-violet. The result of the investigation shows that all ordinary glasses, even the clear optical glasses, suppress all the ultra-violet radiations certainly known to have a specific harmful effect upon the human eye. As to the rest of the ultra-violet, say from 300 μμ to the visible rays, there is little clinical evidence of injurious effect. If it is desirable in certain cases to cut off the whole ultra-violet, there is a liberal choice of entirely effective glasses available. The common commercial amber glasses, used for spectacles and signal glasses, seem to be quite as effective as those specially made. The very light tints may transmit faint traces of the rays nearest the visible spectrum. For protection against powerful sources of light, at close range, only the deepest tints reduce the visible light sufficiently, and these are particularly opaque to the ultra-violet. Among arc-lamp workers and operators of electric furnaces, cases of *ophthalmia electrica*, which is chargeable to the extreme ultra-violet rays, are rare compared with distressing symptoms due to the luminous rays. The author is convinced, from long experimenting, that the dangers to the eye from the quartz lamp, although not negligible under extreme conditions, have been much exaggerated, and thus confirms recent statements of Birch-Hirschfeld [XI. Congresso Internazionale di Oftalmologia]. In working close to the lamp, his eyes were protected by spectacles, but such protection was found unnecessary in ordinary working about the laboratory with the quartz lamp. One spectrogram shows that even a first-class modern photographic lens is almost opaque to wave-lengths less than 365 μμ. Loss by reflection in lenses is serious in this region; in a 4-lens separated system it may amount to 35 per cent. As Zschimmer has shown, Uviol glasses transmit to 265 μμ when 2 mm. thick, and to 295 μμ when 10 mm. thick, while spectra through ordinary glasses usually terminate near 300 μμ. A. E.

866. *An extremely Long-waved Radiation of Mercury Vapour.* **H. Rubens** and **O. v. Baeyer.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 14. pp. 339–345, 1911. Phil. Mag. 21. pp. 689–695, May, 1911.)—The authors have succeeded in isolating from the radiation of the mercury lamp a bundle of heat rays of mean wave-length 313 μ, or nearly $\frac{1}{3}$ mm., in sufficient quantity for investigation. Rubens and Wood's quartz lens apparatus was employed [see Abstract No. 220 (1911)]. The lamp gives the best results with high energy; a current of 4 amps. at 100 volts with an arc of 80 mm. causes the radio-micrometer to deflect 50 mm. A table is given showing the transparency of numerous substances to the long waves from (1) the Auer mantle, and (2) the mercury lamp, which are isolated by the quartz lens apparatus. The transparencies of the same substances to mercury lamp rays after filtration through sheets of quartz or black cardboard are also shown. Natural quartz is extraordinarily transparent to the new rays, which require to travel through eight times as great a thickness of it as do the rays (107 μ) from an Auer mantle, in order to suffer the same loss of intensity. The same proportion holds for amorphous quartz, which, however, is twenty times as absorbent as natural quartz for both kinds of ray. Glass, fluorite, sylvin, and rock-salt appear to have their main absorption belts in the region below 100 μ. Paraffin, vulcanite, and amber show high transparency, as would be expected from their insulating properties; and diamond and selenium also show low absorption. Water absorbs the long mercury radiation much less than it does the radiation from the Auer; its reflecting power in the new region appears also to be small, and therefore presumably its index also. Interferometer measures of wave-length gave a curve of irregular character until a filter of quartz, or, better, black card, was placed in the path of the rays, when the curve took a wave-like form. It is not possible to decide from the interferometer measures whether the long new radiation is of the luminescent type, consisting of several distinct narrow portions of the spectrum, or of the thermo-actinic type, consisting of a continuous radiation covering a wide region. Reasons are advanced for the inference that the radiation under discussion comes from the mercury vapour itself, and not from the heated quartz tube of the lamp. A. E.

867. *Visual Inhibition accompanying Reassociation of Two Retinal Images dissociated by Prisms of Stereoscope.* **A. Chauveau.** (Comptes Rendus, 152. pp. 481–487, Feb. 27, 1911.)—The author, whose vision is more acute with one eye than the other, finds that, when using the stereoscope, if some details be lacking in that member of the double picture which is placed in front of the stronger eye, then these details will also be lacking in the composite picture formed by both eyes. In other words, the stronger eye inhibits vision by the weaker eye of those details not presented to itself. Observers whose eyes are alike could test the result by dimming one lens of the stereoscope. A. E.

868. *Dispersion in Vapours of the Alkali Metals.* **P. V. Bevan.** (Roy. Soc. Proc., Ser. A. 85. pp. 58–76, March 14, 1911.)—A continuation of a previous investigation [see Abstract No. 48 (1911)]. Measurements of 80 lines of the Rb absorption spectrum are given and compared with the values derived from Hicks' formula. The divergences are within the limits of error, but would be diminished by a slight change in the constant "A" of the formula. Rb also possesses a channelled-space spectrum, and the wave-lengths of the heads of its bands were determined. The range of the ratios of these wave-lengths to the wave-length of one line of the first pair of the principal series is much the same as for Na, K, and Li. The dispersion curves of Rb, Na, and K (the last as regards temperature effect), were investigated by the method of crossed prisms. Photographs showing the deviations are reproduced. Measurements of deviations for Rb are in fairly close agreement with curves derived from Sellmeier's dispersion formula. The early lines of the Rb series are pairs separated so far as to require two constants for each pair; the ratio of these two constants is assumed the same throughout the series. The dispersion of Na was investigated near a few lines of the principal series, other than the D-lines which have been investigated by Wood. The observations indicate a departure from normal deviation at the ends of the dark region of the channelled space absorption spectrum examined by Wood. A similar phenomenon was observed for potassium near the corresponding region. On the view put forward in the earlier paper that different specialised atoms are engaged in the absorption of the different spectral lines, it seems probable that the relative numbers of these special atoms should depend on the temperature of the vapour. An examination of the effect of temperature on the relative values of the constants of the dispersion formula for Na, and also for potassium, indicates that there is a real change in the relative values, dependent on the temperature. This being so, we cannot expect any relation between the dispersion constants of the different metals, as such relation would only appear when the vapours were at corresponding temperatures, and we do not know which temperatures do correspond. Three new lines were found in the red spectrum of Ne, which was used for comparison at one stage of the investigation. A. E.

869. *Absorption Spectra of Lithium and Cæsium.* **P. V. Bevan.** (Roy. Soc., Proc. Ser. A. 85. pp. 54–58, March 14, 1911.)—Measures of lines for the three alkali metals, K, Rb, and Cs were given in a former paper. [See Abstract No. 910 (1910).] Lithium vaporises at a higher temperature than the other alkali metals, and at the high temperature required it attacks the material, steel, glass, &c., of the tubes. However, by using a large quantity of Li in a steel tube, sufficient vapour was obtained to give an absorption spectrum showing 27 lines of the principal series, of which 17 are new. A second steel tube was placed in the outer one to protect it. The source of light was the Cd spark, as the limit of the series is much further in the ultra-violet than for the other alkali metals. In addition to the principal series of lines there is a fluted region between λλ4500 and 5500, corresponding fairly well in position with the Na fluted region. The region is in appearance like those of Na and K, and appears under similar circumstances. Hicks' modified Rydberg formula [see Abstract No. 898 (1911)] gives good agreement for the calculated and observed values of the wave-length, but it would give better if the constant A were increased. According to Hicks' work, the Li series is of a different type from the principal series of the other alkali metals. From the physical point of view, however, it appears to behave just as they do. Hicks has pointed out that in the author's earlier measures of the principal series of Cs some of the later lines show departure from the values calculated by his formula. The author has remeasured the Cs lines, and finds that a change in the constant A of Hicks' formula would make the observed and calculated values agree, all the differences being of the same sign. A. E.

870. *Variations of Spectrum Lines with Current and Pressure.* **P. G. Nutting** and **O. Tugman.** (Bureau of Standards, Bull. 7. pp. 49–70, Feb., 1911.)—Three typical gases, hydrogen, argon, and helium, have been experimented on to study the variations of line intensity with definite variations of current and pressure. The gases were enclosed within special Plücker tubes having glass or porcelain capillaries, operated by alternating current at 5000–10,000 volts. With hydrogen the readings were made on the lines H_α, H_β, H_γ in the secondary spectrum, and on small regions near λλ611, 545, 460 in the primary spectrum. The red line is found to vary more rapidly with the current density than the other lines. The primary spectrum showed no apparent selective change even at the highest currents. With variations of pressure from 0·25 mm. to 10 mm. at constant current neither primary or secondary spectrum showed any selective effect. In the case of argon it is well known that as the charge is made disruptive the spectrum changes from the "red" to the "blue" stage, this being due to the production of additional strong lines in the blue region of the spectrum. Five of the most prominent lines were selected for study. From the curves plotted to show the observations it is seen how wide are the departures of line intensity from proportionality to current strength. All the primary lines rise very abruptly and then become nearly constant at high currents, while the secondary groups rise slowly at first and then very steeply. There is no indication that these secondary lines appear abruptly at a large value of the current, but rather that they start at or near zero current. The blue and violet lines are most sensitive to pressure-changes, the red line least. With helium it is found that the spectrum does not vary as the discharge is made disruptive, all the lines increasing less and less rapidly with increase of current, thus showing the characteristics of primary lines. C. P. B.

871. *Effect of Pressure upon Arc Spectra.* **W. G. Duffield.** (Roy. Soc., Phil. Trans. 211. pp. 33–73, March 20, 1911.)—The spectrum of the silver and gold arcs was photographed under pressures ranging from 1 to 201 atmos. in the region λ = 4000 to λ = 4600 Å. The arcs were formed between poles of the pure metal ¼ in. in diam. within the pressure cylinder previously used [see Abstracts Nos. 284 and 780 (1908)]. The second order spectrum was employed, a 21½-ft. Rowland grating spectroscope being used. Within the region mentioned it was found that all silver lines broaden under pressure. The broadening increases with the pressure, but different amounts of exposure make it difficult to determine if the increase is continuous and linear with the pressure. The broadening of the two first sub-series lines is, at normal atmospheric pressure, unsymmetrical relatively to the superposed absorption line; increase of pressure increases the width of these lines, and their wings are then seen to consist of numbers of fine lines which merge into one another at higher pressure. The broadening of the second sub-series line (4476·29) at normal atmospheric pressure is unsymmetrical, being greater on the red side. Under pressure this is more pronounced, but the line remains definite, though its intensity diminishes. The broadening of the non-series line is distinctive, because the line appears to become the violet edge of a band which stretches further towards the red as the pressure is increased, but at the highest pressure the violet edge has lost its character as the head of a band. The distinction that was observed in the same region of the copper spectrum is here also apparent; the first sub-series lines become hazy under pressure, resembling hazy bands, and finally leaving only a cloudy, banded appearance on the plate; the second sub-series lines remain definite lines without abnormal broadening, though they ultimately disappear through a gradual weakening process. No relation was found between the original intensity of a line and its width under pressure. The magnitude of the broadening of the first sub-series lines is at 20 atmos. as great as 120 Å. With the gold arc the lines investigated ranged down to λ = 3550. Elaborate measurements were made of the displacements of the lines, and it was found that the displacement (*d*) can be expressed in terms of the wave-length fairly well by the relation $d = K \times 10^{-14} \lambda^3$, where K is a constant whose value is different for three groups of lines. The prominent features of the gold arc are the broadening of the lines, their displacement towards the red end of the spectrum, the changes in relative intensity, and the absence of reversals. These are discussed in detail and photographs given fob various pressures throughout the range. A. W.

872. *Pressure Displacement of Spectral Lines.* **R. Rossi.** (Phil. Mag. 21. pp. 499–501, April, 1911.)—If the pressure displacement is a linear function of the specific inductive capacity of the radiating vapour the experimental methods so far available are not accurate enough to prove it, on account of the small differences of the specific inductive capacities of different gases; but if it is proportional to (μ^2-1), as claimed by some authors (μ being the refractive index of the medium surrounding the vibrating atom), considerable changes in the displacements ought to be detected by surrounding the source of light with different gases. The displacements of some lines of the spectrum of an iron arc burning in air and in CO_2 were compared. Hydrogen was also tried, but the arc burns so poorly in that gas under pressure that good results could not be obtained. Photographs were taken at 15, 30, and 50 atmos. with a 21·5-ft. grating spectrograph, and the results are tabulated. The mean displacement per atmo. of all the 23 lines studied is found to be 0·00411 and 0·00401 Å. for the arc burning in air and CO_2 respectively. Hence, so far as this evidence from only two gases is worth, it points to the conclusion that the specific inductive capacity is of but secondary importance in the cause of the displacement of spectral lines. This is also in accordance with experiments by Humphreys and by Duffield, who, using pure metals and alloys of those metals, or carbon poles with metallic impurities, found practically the same pressure-displacements in each case. All these facts seem to show that the pressure displacement is not a density effect, but is due to the total pressure of the radiating vapour—*i.e.*, to the compactness in number of atoms, irrespective of their kind. [See also Abstract No. 51 (1907).] A. W.

873. *Structure of Spectral Lines.* **H. Brotherus.** (Phys. Zeitschr. 12. pp. 193–196, March 15, 1911.)—A photometric method was employed to study the structure of several spectrum lines; those dealt with in the present paper are the red hydrogen line and the sodium D-lines. The principle on which the action of the photometer is based is that given by Voigt, the two beams of light to be made equal being first polarised perpendicular to one another and then mixed. The disappearance of the interference bands is the criterion for determining when the two beams are of equal intensity. The red hydrogen line is double, and the author finds the distance of the two maxima to be 0·124 Å. The ratio of the max. intensities was 9 : 5, the ratio of the total intensities being 14 : 5. Michelson found the distance apart to be 0·14 Å. and the ratio of max. intensities to be 10 : 7. The same method was used for the D-lines. Using an apparatus similar to that used by Arrhenius and by Wilson, the amount of Na vapour could be varied at will by altering the concentration of the solution. As the concentration is increased each line becomes double, the separation increasing and becoming more definite as the concentration increases. Both intensity curves are non-symmetrical; the discussion of this will be given later. A. W.

874. *Spectrum of Poulsen Arc.* **E. O'Connor.** (Phys. Zeitschr. 12. pp. 196–198, March 15, 1911.)—La Rosa investigated one type of oscillating arc [Abstract No. 1216 (1909)], and found that as the capacity of the oscillation circuit was increased, the spectrum of the Duddell arc gradually changed into the spark spectrum, and that by introducing extra self-induction the arc spectrum was produced. In the present research the Poulsen arc was dealt with, and it is shown that the spectrum of the arc, under the conditions in use under the Poulsen system of wireless telegraphy, is practically that of the atmosphere, thus giving spectroscopic confirmation of the theory of the production of electric oscillations. A. W.

875. *Spectra of Gases in Extreme Ultra-violet.* **T. Lyman.** (Astrophys. Journ. 33. pp. 98–107, March, 1911.)—Tables are given of the spectra of the gases O, H, N, He, and A in the extreme ultra-violet region, in continuation of former investigations [Abstracts Nos. 1052 (1906), 814 (1910)]. In the cases of He and oxygen no lines are found in the region more refrangible than λ1900. In the spectrum of nitrogen two types of lines are present, one consisting of faint bands with heads directed towards the violet, the other comprising two pairs of sharp lines. Argon yields no lines of the red spectrum in this region, but there are a considerable number of lines in the blue spectrum. The article includes a description of the apparatus and methods employed for the investigation, with notes on the precautions taken to eliminate impurities from the gases examined. C. P. B.

876. *Spectrum of Carbon.* **M. La Rosa.** (Ann. d. Physik, 34. 2. pp. 222–234, Feb. 8, 1911.)—An investigation of the spectrum of a carbon rod electrically heated to incandescence. Various interesting phenomena are described at length, and photographic reproductions of the different spectra are given. Reversal of lines in the Swan spectrum is dealt with, and a full discussion is given of the origin of this spectrum. From research on the spectrum obtained in an oxygen-free space and from other considerations it seems most probable that the Swan spectrum is due to carbon vapour. The latter part of the paper treats of the behaviour of lines due to metallic impurities, and the localisation of the different emission-centres in the arc. A brief abstract cannot be given. [See Abstracts Nos. 688, 2156 (1909).] A. W.

877. *Argon Spectra.* **W. Stahl.** (Zeitschr. wiss. Phot. 9. pp. 302–312, April, 1911.)—Measurements of the lines of argon have been made by Kayser, Runge and Paschen, Eder and Valenta, and others. Using a Rowland grating of 6·5 m. radius and 20,000 lines to the inch, the author has remeasured the lines of the "blue" and "white" argon spectra. Tables are given of the results, several new lines being shown. The max. difference between the wave-lengths of lines measured in both spectra is 0·08 unit. Where the same lines were measured by Kayser and Eder and Valenta there is an approximately constant difference; but their results were based on Rowland's normal spectrum, while Stahl used that of Fabry and Buisson. Photographs and measurements of the lines in the red part of the "blue" spectrum were obtained, these having previously only been observed with the eye. In general, the results agree better with Kayser's values. A. W.

878. *Zeeman-effect in Weak Magnetic Fields.* **H. Lunelund.** (Ann. d. Physik, 34. 3. pp. 505–542, March 9, 1911.)—Using a 35-plate echelon grating the structure of various spectral lines was studied, and their behaviour in weak magnetic fields observed. For much of the work an Heræus amalgam lamp was used; this contains a mixture 60 per cent. Hg, 20 Pb, 20 Bi, 0·5 Zn, and 0·5 per cent. Cd, and gives many fine lines. The lines studied were the following: Hg 5790, 5769, 5461, 4916, 4359, 4348, 4339, 5078, 4047; Cd 6439, 5086, 4800, 4678; Zn 6362, 4810, 4722, 4680; Bi 4722, 4122; Pb 4058. Tables are given showing the structure of these lines, and comparison is made with

the results of other workers. The complicated phenomena observed when these lines are subjected to magnetic fields are discussed at length, and comparison tables again given. The fields used varied from about 1000 to 5000 c.g.s. A. W.

879. *Zeeman-effect for Chromium.* **H. D. Babcock.** (Astrophys. Journ. 33. pp. 207–233, April, 1911. Contributions from the Mount Wilson Solar Observatory, No. 52.)—The study of the Zeeman-effect on the spectrum lines of chromium was undertaken for the extension of the study of sun-spot lines. All the later photographs have been taken with a powerful Littrow-spectrograph giving a scale of 0·95 Å. per mm. For the production of the field a Du Bois electromagnet was employed, giving field strengths from 15,000 to 25,400 c.g.s. with about 14 amps. Tables are given showing the wave-lengths, order of separation, amount of separation, for all the lines examined. C. P. B.

880. *Destruction of Fluorescence of Iodine and Bromine Vapour by other Gases.* **R. W. Wood.** (Deutsch. Phys. Gesell., Verh. 13. 1. pp. 72–77, Jan. 15, 1911. Phil. Mag. 21. pp. 309–313, March, 1911.)—Study of the fluorescence of sodium, potassium, mercury, and iodine vapour has shown that the intensity of the emitted light is greatly reduced if air, or some other chemically inert gas, is present [see Abstracts Nos. 341, 469, 470 (1911)]. Iodine vapour is the easiest to study, since its fluorescence can be observed at room temperature in glass bulbs, and the conditions of pressure, density, &c., can be accurately determined, which is nearly impossible with sodium vapour. A satisfactory theory of fluorescence should not only explain the destruction by the inert gas, but also the failure of bromine to show any trace of fluorescence under the same conditions as iodine vapour. Its absorption spectrum is very similar, and yet it usually remains quite dark even under the most powerful excitation. Some years ago the author suggested the hypothesis that the molecule might be capable of storing up a certain amount of energy without the emission of light, but that a saturation point must be reached eventually, after which there would be emission. Assuming that on collision with another molecule the energy absorbed by the molecule is transformed into heat, the internal energy dropping back to its original value, and the molecular velocity increasing in proportion, it is clear that if the mean free path is traversed before the saturation-point is reached there will be no fluorescence. On this hypothesis, the failure of Br to fluoresce would be explained by ascribing to the Br molecule a greater capacity for storing energy. In other words, the path cannot be increased sufficiently to allow the saturation-point to be reached before a collision occurs. On sufficiently increasing the length of free path, by diminishing the pressure, fluorescence ought to become manifest, provided that enough molecules remain to produce a visible illumination. To test the point, sunlight was concentrated upon a bulb of extremely rarefied Br vapour, and the wall of the bulb cooled by touching it with a piece of solid CO_2, which gradually condensed the Br upon the wall. In 2 or 3 seconds a faint green fluorescence appeared, which vanished almost immediately, owing to the complete removal of the Br vapour. This experiment would seem to support the above hypothesis, but further investigation has shown that another factor has to be considered.

The effect upon intensity of fluorescence of mixing a small quantity of air, hydrogen, CO, or ether, with iodine in a vacuum bulb was investigated. The curves for fall of intensity with increase of pressure show that the hypothesis of free path and energy saturation does not fit the facts; and also that the influence of the foreign gas on the fluorescence is not proportional to the atomic weight. The probable explanation of the curves is given in another paper [Abstract No. 469 (1911)]. The only difficulty in measuring the intensity of fluorescence arises from a slight change in the colour, which takes a ruddy tinge for high pressures of the foreign gas, as if the admixture weakened the green fluorescent light more than the red. Experiments were also made with a highly exhausted bulb of pure iodine vapour at various temperatures. Below room temperature the relation between intensity of fluorescence and temperature is very nearly linear. Above room temperature the intensity remains about the same up to 80° C., after which it gradually decreases to zero. Probably increased absorption nearly compensates for any increase that may occur above room temperature. A. E.

881. *Kathode Luminescence in Minerals.* **A. Pochettino.** (N. Cimento, Ser. 6. 1. pp. 21–64, Jan., 1911.)—Continuing his work on this subject [see Abstract No. 875 (1910)] the author has compared the behaviour of a large number of minerals and the corresponding artificial crystals when exposed to kathode rays. The effect on the artificial crystals is found to be practically identical with that on the natural mineral, the similarity extending with zircon even to the phenomenon of dichroism, with willemite and red corundum to the spectral composition of the light emitted, and with willemite to the behaviour when submitted to kathode rays of different velocity. Kathode luminescence persists longer in natural than in artificial calcite and phenacite, and phosphorescence longer in natural than in artificial willemite. The spectral constitution of kathode luminescence is not invariably independent of the velocity of the kathode rays, increase of this in the case of spodumene causing not only an increase in intensity of the radiation emitted, but also emission of a more refrangible radiation, and in the case of distene, emission of a less refrangible radiation. Double crystals usually give a much less polarised luminescence than simple crystals of the same substance, and dichroism must be attributed to the presence of impurity in the crystals. The theory that the excitation converts a more stable into a less stable form does not satisfactorily account for residual luminescence, since (1) the higher the temperature of the substance is raised, the greater is the extinction of the luminescence; (2) whilst the duration of excitation does not sensibly influence the intensity of the initial luminescence, extinction of luminescence is greater for shorter duration of excitation; (3) for the same substance, the residual luminescence lasts longer when crystalline than in the amorphous or micro-crystalline form. W. H. St.

882. *Rays from the Alkaline Metals.* **E. Henriot.** (Comptes Rendus, 152. pp. 851–853, March 27, 1911.)—The salts of potassium emit a very penetrating radiation, and the salts of rubidium emit a radiation which is less penetrating but more intense; on the other hand, no radiations from the salts of caesium have been observed. If the electrons emitted by potassium have a very great velocity, and those emitted by rubidium a smaller velocity, it may be that there are electrons emitted by caesium with insufficient energy to cause ionisation. In order to ascertain if such is the case an attempt is now made to catch the particles given off and measure their charge, but the results obtained so far as Cs is concerned, are of a doubtful nature on account of the extreme smallness of the charge measured. J. J. Thomson and others have found that Rb and the Na-K alloy emit negative corpuscles even when kept in the dark, and the magnitude of the current measured is such as to suggest that the extremely small current now obtained with the salts of these metals must have a different origin. Experiments are, however, now arranged in which great care is taken to shut out external influences, and the results obtained indicate that the relatively large currents previously observed with the metals ought to be attributed to traces of light penetrating into the apparatus, or other accidental cause. A. E. G.

883. *Secondary Röntgen Rays (Sagnac's Rays).* **H. Guilleminot.** (Comptes Rendus, 152. pp. 595–598, March 6, and pp. 763–766, March 20, 1911.)—Sagnac and Curie have shown that in the secondary rays emitted by matter when submitted to the action of Röntgen rays there exist slightly penetrating negative rays analogous to the kathode rays. When these rays are removed by filtering, the secondary rays are reduced to a radiation of the same nature as the Röntgen rays. It is generally considered that this radiation is composed of new rays of different quality to the primary rays, and cannot be looked upon as consisting of diffused primary rays. These experiments upon the secondary rays produced by light metals, such as Al, and by organic substances, lead to the conclusion that the secondary rays are produced by a simple diffusion of the primary bundle of Röntgen rays. When a quasi-monochromatic Röntgen-ray bundle is considered, it is found that the secondary rays produced have the same coefficient of penetration, the same quality, and in fact differ in no respect from the primary rays. It is shown that the sum of the secondary rays transmitted in a given direction is $\Sigma RS = zI_0(1 - k^{2n})/(1 + k)$, z being the coefficient of diffusion in the direction under consideration, and k the coefficient of transmission of the incident Röntgen rays for an elementary layer. When k is expressed as a function of K, the practical coefficient for 1 mm. of Al, we may write $k = K^{1/m}$, m being the number of elementary layers in 1 mm.; the formula then becomes $\Sigma RS = zI_0(1 - K^{2n/m})/(1 + K^{1/m})$, and for infinitely thin elementary layers $\Sigma RS = zI_0(1 - K^{2l})/2$, where l is the thickness of the layer used. Thus, the intensity of the secondary rays emitted may be expressed as a function of the intensity of the primary Röntgen rays, and of the coefficient of penetration of that radiation. The object of the experiments described in the second paper is to determine whether z is a constant for all the monochromatic Röntgen rays which are contained in a bundle of primary rays. The conclusion arrived at is that the proportionality of the secondary rays produced, and of the quantity of Röntgen rays absorbed by the elementary layers of Al, extends to all qualities of Röntgen rays, and that the coefficient z is the same for all Röntgen-ray bundles. The very soft rays have, however, not been studied with sufficient accuracy to be able to decide in their case. (Ibid. pp. 1092–1095, April 24, 1911.)—The conclusion arrived at is that the secondary Röntgen rays, not deviated by Al, consist of scattered primary rays and not of a new radiation, and that the formula of transmission as employed for the primary bundle is applicable to them. A. E. G.

884. *Polarisation of Röntgen Rays from an Antikathode of Silver.* **F. C. Miller.** (Frank. Inst., Journ. 171. pp. 457–461, May, 1911.)—Barkla has found by experiments on secondary rays that the primary beam of Röntgen rays is partially polarised; H. Haga, by use of the photographic method, decided that no polarisation of the primary rays exists [see Abstract No. 1518 (1907)], but J. Herweg, by use of the same method, came to the opposite conclusion [Abstract No. 1542 (1909)]. W. R. Ham, by use of the ionisation

method and direct experiments on the primary rays, not only showed that the intensity of the rays is a maximum in a direction at right angles to the kathode stream, but that the intensity decreases symmetrically on either side of this plane. Ham's experiments were made with lead antikathodes [see Abstract No. 879 (1910)]. From his data we should expect polarisation of rays from other metals, and that those from silver are polarised to a greater extent than those from lead. The present experiments were to test this point. The apparatus used was practically the same as that used by Ham, and the results show that, within experimental error, no difference exists in the polarisation of Röntgen rays from a lead target and a silver target.
A. E. G.

885. *Scattering during Radio-active Recoil.* **W. Makower** and **S. Russ.** (Manchester Lit. and Phil. Soc., Mem. 55. 2. pp. 1–4, Jan. 23, 1911.)—In the experiments described a plate was mounted in such a way that it was outside the recoil stream from a wire coated with RaA, but so that recoil atoms reflected or scattered from a copper reflector could reach it. After an exposure of a few minutes the plate was found to have an activity which, determined by its decay curve, consisted of RaB and RaC in about equal proportions. The authors explain this result by assuming that when the RaB impinges on the reflector, a small portion of it is scattered on to the plate, but the greater part remains on the reflector, and subsequently gives rise to RaC, a small fraction of which is then directly projected on to the plate. The results also appear to indicate that the proportion of RaC atoms which recoil from the surface of the copper reflector to the total number formed there, is greater than the fraction ($\frac{1}{1000}$) previously determined for the ordinary case.
E. M.

886. *Action of Small Elevations of Temperature on Excited Radio-activity.* **E. Sarasin** and **T. Tommasina.** (Comptes Rendus, 152. pp. 434–436, Feb. 20, 1911.)—The authors have found that when the temperature of a metal plate coated with the active deposit of Ra is raised by 20 or 30 deg. C., the activity is temporarily increased by a considerable amount. This effect is found with both the active deposit of short and long decay, although it is absent when glass is used.
E. M.

887. *Radio-activity of Thorium.* **E. Rutherford.** (Röntgen Soc., Journ. 7. pp. 28–29; Discussion, pp. 29–30, April, 1911.)—The paper consists of a discussion of the properties of the various products of the thorium family, more especially of mesothorium, which is also discussed from the aspect of its suitability for many purposes for which Ra is used. The thorium series is given as follows:—

	Thorium →	MesoTh(1) →	MesoTh(2) →	RadioTh →
Radiation.........	α		β γ	α
Half-time period	$1·5 \times 10^{10}$ years	5·5 yrs.	6 hrs.	2 yrs.

		Active deposit			
ThX →	Eman. →	ThA →	ThB →	ThC →	ThD
α	α	β	α	α	β γ
8·6 days	54 sec.	10·6 hrs.	1 hr.	?	8 min.

E. M.

888. *γ-Rays of Thorium and Actinium.* **A. S. Russell** and **F. Soddy.** (Phil. Mag. 21. pp. 130–154, Jan., 1911.)—In the present paper similar experiments to those described in previous papers [Abstracts Nos. 1889 (1909) and 1252 (1910)] on the γ-rays of UrX and RaC have been carried out with the γ-rays from AcC, ThD, and MesoTh(2). With regard to the relative intensities of the β- and γ-rays from these products considerable differences were found according to the method of measurement employed, but the general order of the results was the same and showed that MesoTh(2) gives slightly more γ-radiation per β-ray than RaC, and ThD somewhat less. With AcC the γ/β ratio was only about 1/8 to 1/16 that of RaC, thus being of the same order as that previously found for UrX. Measurements of thorium minerals indicated the same results for MesoTh(2) and ThD, and also showed that in thorite ThD contributes more β-radiation that MesoTh(2). Extensive experiments are described on the variation of the absorption coefficient of γ-rays, showing that a value of λ for an absorbing substance is meaningless unless a full account of the experimental disposition under which the measurements were made is given. Experiments were also made on the relative penetrating powers of the various γ-rays; these were found to be, in ascending order: AcC, UrX, MesoTh(2), RaC(C_1), and ThD. Omitting the γ-rays from AcC which show many anomalies, this is also the descending order of their periods and of their probable atomic weights, the former relation being analogous to Rutherford's rule for the ranges of α-particles. The order of the penetrabilities of the γ-rays is also that of the ranges of the α-rays which both precede and follow them, whereas the order of the penetrabilities of the β-rays is quite different, being: MesoTh(2), ThD, UrX, and RaC(C_1). Thus the β-rays are not obviously connected with the γ-rays, whereas there is a certain connection between the γ-rays and α-rays.

E. M.

889. *Ionisation of Different Gases by α-Particles.* **T. S. Taylor.** (Amer. Journ. Sci. 31. pp. 249–256, April, 1911. Phil. Mag. 21. pp. 571–579, April, 1911.)—In previous papers [Abstracts Nos. 1628 (1908), 1887 (1909)] the author has shown that the air equivalents of metal foils decrease with the speed of the α-particles entering the foils, while the air equivalents of hydrogen sheets increase with decreasing speed of the entering α-particles (the air equivalent being defined as the amount by which the range of the α-particle in air is cut down by its passage through the foil or sheet). This latter result was found to be accounted for by differences in the Bragg ionisation curves obtained in hydrogen and air, and the author has now extended his experiments to other gases. The Bragg ionisation curves, or curves giving the relative ionisation at different points of the path, were determined in each case, the ranges of the α-particles from a polonium source being made the same in the different gases by adjusting the pressure. For all the gases examined the ionisation at any point distant x from the source was found to obey the law $I = c/(r-x)^{1/3}$ previously found by Geiger [Abstract No. 1250 (1910)], c being a constant for the gas employed and r the mean range of the α-particles. The area under the ionisation curves was found to vary with different gases, thus indicating differences in the total number of ions produced in the various gases by an α-particle. As the energy spent by an α-particle in the different gases is the same, the reciprocals of these areas give the relative amounts of energy required to produce an ion, the results being: Air (1·0), H_2 (1·01), CH_3I (0·75), CH_4 (0·85), C_2H_5Cl (0·77), CS_2 (0·78), N_2 (1·04), CO_2 (0·99), O_2 (0·88), $C_4H_{10}O$ (0·74), SO_2 (0·97), HCl (0·77), HBr (0·77), HI (0·77). The heavier and more complex molecules are therefore apparently more readily ionised than the lighter and less complex ones, indicating that their electrons are in a less stable arrangement. **E. M.**

890. *Range of α-Particles of Uranium.* **A. Foch.** (Le Radium, 8. pp. 101–104, March, 1911.)—A screen of zinc sulphide was placed at the centre of a spherical bulb whose sides were thinly coated with uranyl acetate. Scintillations were counted for different pressures of the air in the bulb, and the pressure at which they disappeared was used to calculate the range. The value found was 2·68 cm. ± 1 mm., which agrees with that found by Rutherford and Geiger [Abstract No. 850 (1911)]. Some little evidence was also obtained that Ur emits two sets of α-particles, as indicated by Boltwood's experiments. [Abstracts Nos. 1100 (1908), 850 (1911).] **E. M.**

891. *Effect of Temperature on Absorption Coefficient of Iron for γ-Rays.* **W. Wilson.** (Phil. Mag. 21. pp. 582–584, April, 1911.)—The paper deals with the negative result of an experiment to determine whether the absorption coefficient of iron for γ-rays varies with temperature. γ-rays from $RaBr_2$ passed through a block of iron 7 cm. thick and produced ionisation in an electroscope; the iron was heated to varying temperatures up to 678° C. and the leak measured. The ionisation was slightly greater at high than at low temperatures, a rate of increase of 0·0020 per cent. per 1 deg. C. being obtained; but this was calculated to be entirely due to the change of the density of the iron. **E. M.**

REFERENCES.

892. *Direct Reading Candle-power Scale and Recording Device for Photometry.* **G. W. Middlekauff.** (Bureau of Standards, Bull. 7. pp. 11–43, Feb., 1911.)—A more comprehensive account of the device described in Abstract No. 787 (1910). **J. S. D.**

893. *Ratio of Emissive to Absorptive Power in the case of Strongly Absorptive Bodies.* **M. Born** and **R. Ladenburg.** (Phys. Zeitschr. 12. pp. 198–202, March 15, 1911.)—Mathematical.

894. *Measurement of the Refractive Index of Liquids.* **O. W. Griffith.** (Phil. Mag. 21. pp. 301–309, March, 1911.)—Describes two simple methods.

895. *Radiant Energy and Matter.* **J. J. Thomson.** (Engineering, 91. pp. 319–321, March 10; 353–354, March 17; 386–388, March 24; 421–422, March 31; 454–455, April 7, and pp. 491–492, April 14, 1911. Lectures delivered at the Royal Inst.)

896. *Isolation of Long Heat-waves by Quartz Lenses.* **H. Rubens** and **R. W. Wood.** (Phil. Mag. 21. pp. 249–261, Feb., 1911.)—[See Abstract No. 220 (1911).]

897. *Curvature of the Spectrum Lines in a Concave Grating.* **A. Eagle.** (Phys. Soc., Proc. 23. pp. 233–236, April 15, 1911.)—An investigation in which terms higher than the third order are omitted.

898. *Critical Study of Spectral Series.* I. *The Alkalies, H and He.* **W. M. Hicks.** (Roy. Soc., Phil. Trans. 210. pp. 57–111, Feb. 9, 1910. Proc. Ser. A. 83. pp. 226–228, Jan. 7, 1910. Abstract.)

HEAT.

899. ***Molecular Heat Conductivity of Gases and the Coefficient of Accommodation.*** **M. Knudsen.** (Ann. d. Physik, 34. 4. pp. 593–656, April 7, 1911.) —The results obtained by the author are summarised as follows: (*a*) By the application of the kinetic theory to the passage of heat through a gas between two parallel plates at different temperatures, it is found, under the assumption that the distance between the plates is vanishingly small compared with the mean free path of the gas molecules and the dimensions of the plates, that $Q = S\tau(T_1' - T_2')p\epsilon$, where Q is the transported heat in gm.-cals., S the area of the plates in cm.^{2}, τ the time in seconds, $T_1' - T_2'$ the temperature-difference between the plates, p the pressure of the gas in dynes per cm.^{2}, and ϵ the coefficient of molecular heat conduction. The theory shows that ϵ depends only on the nature of the gas, and alters only with pressure in so far as the ratio c_p/c_v does so. It is therefore independent of the distance between and the nature of the plates. (*b*) Experiment showed that the apparent molecular heat conductivity is less than that given by the above theory, but it approaches the theoretical value as the roughness of the surface of the plates increases. Under like conditions the apparent value of ϵ is a much smaller fraction of the theoretical value in the case of hydrogen than in the case of oxygen and CO_2. (*c*) The author modifies the theory by the introduction of a "coefficient of accommodation," a, which can be represented as the ratio of two temperature-differences, $a = (T_1 - T_2)/(T_1 - T_2')$, where T_1 represents the temperature of the group of gas molecules which are approaching a solid wall, T_2 the temp. of the group of gas molecules leaving the wall, and T_2' the temp. of the wall. (*d*) Introducing the accommodation coefficient, the apparent coefficient of molecular heat conductivity between two smooth parallel walls (ϵ_{11}) is given by the expression $\epsilon_{11} = \epsilon a/(2 - a)$. When the surfaces are absolutely rough, $a = 1$ and $\epsilon_{11} = \epsilon$. (*e*) The author has tested this modification of the kinetic theory in the case of the conduction of heat between two concentric glass cylinders, and has found it confirmed. (*f*) The accommodation coefficient of a porous gypsum surface is about the same as that of a glass surface. The accommodation coefficient of a polished Pt surface was found with hydrogen to be 0·26. (*g*) The molecular heat conduction is inversely proportional to the square root of the absolute temperature. (*h*) In the case of thin Wollaston wire (diam. about 0·008 mm.) the air cooling is at high pressures very considerable. With hydrogen under a pressure of 1 atmo. the wire gives off about 20,000 times as much heat by conduction as by radiation. (*i*) In the case of thin, bright, but not quite smooth Pt ribbon at room temperature the accommodation coefficient with hydrogen was found to be 0·86. By coating with platinum black this value rapidly rose to over 0·8. In the case of different gases the higher the molecular weight of the gas the greater is the accommodation coefficient. (*j*) It is probable that the coefficient of heat conduction of a gas (κ) at high pressures is related to the coefficient of molecular heat conduction by the expression $\kappa = k\epsilon p\lambda$, where k appears to have the value about 1·90, p is the gas pressure, and λ the mean path under the pressure p. **A. F.**

900. *Theory of Specific Heat and the Application of the Doctrine of Energy Distribution to Physico-chemical Problems in General.* **W. Nernst.** (Zeitschr. Elektrochem. 17. pp. 265–275, April 1, 1911.)—After showing the insufficiency of the Maxwell-Boltzmann theory of the energy-content of a body, the author discusses the Planck-Einstein theory [Abstract No. 489 (1907)], and calculates out a special case. The relation to the theory of radiation and to the law of Dulong and Petit is next discussed, and it is shown that the occurrence of too small values for the specific heat is to be explained by high frequency of oscillation of the atoms. This is borne out by experiments carried out in the laboratory. It is also possible from the relationship between oscillation-frequency and melting-point and atomic volume to calculate the limit of temperature below which the law of Dulong and Petit begins to be inexact. Other applications of the theory are also given. A. F.

901. *Modification of Mechanism of Flame by Convergent Combustion.* **J. Meunier.** (Comptes Rendus, 152. pp. 706–708, March 13, 1911.)—In convergent combustion, the form of the flame is an inversion of the ordinary flame, the combustible gas enveloping the supporter of combustion, instead of being enveloped by it. Employing an Auer burner, without a mantle, but having a metallic central rod, around the base of which is a spiral of Pt-wire, whilst immediately above is a cone of Pt-foil, the top of the rod being protected by a short constricted lamp-glass, the flame takes a tulip-like form, 2–3 mm. thick, 2 cm. high, and 3–4 cm. wide, of a blue colour, the edge being a deeper blue than the rest of the flame. This border gives the bands of the Swan spectrum, the bands being much more definite than in the exterior blue flame of the Bunsen burner. Other parts of the flame have a uniform tint, and no bands are visible. A portion of the flame, issuing from the centre of the tulip, is almost invisible, and rises exactly in the same way as the ordinary Bunsen flame; this is very hot and is coloured by metallic vapours.

W. H. Si.

902. *Method for determining Heat of Evaporation as applied to Water.* **T. W. Richards** and **J. H. Mathews.** (Amer. Acad., Proc. 46. No. 19. pp. 511–533, April, 1911.)—The authors have taken up the study of heats of evaporation, and communicate, in the present paper, a description of the apparatus employed and of the results obtained in the case of water. After studying the various methods previously used, the authors adopted the principle of that due to Kahlenberg. The vaporiser consisted of a double-silvered Dewar vacuum vessel. In the central axis of this and passing through the double wall was a glass tube through which the vapour from the boiling liquid could pass into the condenser tube in the calorimeter. To prevent liquid drops being carried over by the vapour, a glass hood was placed over the top of the outlet tube; and this was also supplemented by a trap at the bottom of the tube, inside the vaporiser. In previous experiments by this method the chief disturbing effect was found to lie in premature condensation and consequent loss of heat; and the same disturbing effect was encountered here, although various steps were taken to eliminate it. By carrying out a series of vaporisations at different rates it was found that the values of the heat of vaporisation obtained were, practically, a linear function of the rate of vaporisation. It was thus possible by extrapolation to find the value of the heat of vaporisation for instantaneous vaporisation, and so eliminate the disturbing effect referred to. The vapour passed from the vaporiser into a block-tin condenser immersed in water in a nickel-plated copper calorimeter. This was surrounded by alkali and the temperature of this surrounding liquid was raised by addition of acid in proportion as the temperature of the calorimeter water rose. This device to eliminate radiation errors was previously devised by the authors. As a result of their determinations, the authors find for the heat of vaporisation of a true gramme of water at 100°, the value 588·9 cals. at 21°, or 588·1 cals. at 15° or 2·251 kilojoules; or, on the basis of $O = 16$, the molecular heat of vaporisation is 9·707 Cals. (21°) or 40·54 kj. **A. F.**

REFERENCES.

903. *Mechanical Models Illustrating the Second Law of Thermodynamics.* **H. Witte.** (Phys. Zeitschr. 11. pp. 1005–1014; Discussion, pp. 1014–1017, Nov. 1, 1910. Paper read before the 82. Naturforscherversammlung Königsberg, Sept., 1910.)

904. *Conduction of Heat through Rarefied Gases.* **F. Soddy and A. J. Berry.** (Roy. Soc., Proc. Ser. A. 84. pp. 576–585, Feb. 15, 1911.)—Further experiments with hydrogen, helium, and argon have been made in continuation of those already described [Abstract No. 585 (1910)]. Various sources of error have been noticed and some corrected values of the results are given. Further experimental work is required in order to obtain the necessary data for the solution of the questions raised. **J. J. S.**

905. *On the Constant of Radiation.* **C. Fery and M. Drecq.** (Comptes Rendus, 152. pp. 590–592, March 6, 1911.)—The authors have made a new determination of the radiation constant and find for the value of a in the Stefan-Boltzmann equation, 2·078, and for $\sigma = \pi a$, 6·51, numbers completely in harmony with their previous measurements, but differing from those of Bauer and Moulin [Abstracts Nos. 115 and 399 (1910)]. **A. F.**

906. *Kinetic Basis of Nernst's Theorem.* **O. Sackur.** (Ann. d. Physik, 34. 3. pp. 455–468, March 9, 1911.)—The author discusses Nernst's thermodynamic theorem from a kinetic standpoint and employs it to derive an equation of state. The paper is purely theoretical and cannot be given in abstract form. **F. J. B.**

907. *On the Extinction of Flames.* **W. P. Jorissen and N. H. Siewertsz.** (Zeitschr. Phys. Chem. 73. 2. pp. 163–170, 1910.)

SOUND.

908. *Experiments with the Gramophone.* **J. G. McKendrick.** (Nature, 86. pp. 244–245, April 20, 1911.)—An account of further experiments on the gramophone with the view of suppressing the various noises of a "frying-pan" character usually accompanying the production of the sounds obtained from the record itself. This object has now been to a great extent accomplished as follows. The gramophone is enclosed in a wooden cloth-lined box with a tube passing out to the horn. The sounds of the machinery are thus damped off. That of the needle on the record, however, still passes out through the tube. But a considerable length of tubing (54 ft. of ½-in. tube) now intervenes between the box and the horn. Further, a part of this tubing (4 to 8 ft. in length) is filled with a mixture of hard peas and beans, corrugated by age and drying. This diminished the objectionable noises, but also dulled the musical tones. The brilliancy of the latter was then restored by adding fragments of corrugated zinc as suggested and patented by E. De la Rue. [See Abstract No. 1421 (1909).] E. H. B.

909. *Gramophone.* **C. A. Parsons.** (Nature, 86. p. 416, May 25, 1911.)—Referring to the experiments by J. G. McKendrick [see preceding Abstract], the present author recalls his experiments made five or six years ago with the same object; namely, to minimise the objectionable hissing and scratching sounds. A T-shaped tube close to the reproducer was found an advantage, also a flexible joint between the needle and the actual reproducer, the flexibility being obtained by allowing large clearance and filling the space with a highly viscous substance. Further improvements consisted in the introduction of a paper diaphragm or paper, linen, &c., in moderate quantities, in the trumpet. E. H. B.

910. *Microscopic Movement of Particles produced by Sound Waves.* **W. König.** (Comptes Rendus, 152. pp. 1160–1168, May 1, 1911.)—In connection with the papers by Lifschitz, and Henri and Lifschitz [see Abstracts Nos. 575 and 822 (1911)] the author states that the motions produced must in all probability be the same as those produced in light powder in a Kundt's tube; they are therefore similar to the motion of solids in moving liquids. The author has already treated this case in detail (Wied. Annalen, 42. p. 549, 1891). He shows that the experimental results obtained are in accordance with the results predicted by mathematical analysis. The small differences noticed can probably be explained by taking into account the motions of the particles at the moment preceding the shock. It can be proved that the magnitude of the forces depends on the square of the velocity of the liquid. The velocity of the air in the sonorous waves varies with the rapidity of the electric oscillations. Consequently the forces and the amplitudes increase with the rapidity of the electric oscillations. This is in accordance with the experimental results. A. R.

REFERENCES.

911. *Helmholtz's Theory of Combination Tones.* **C. Schaefer.** (Ann. d. Physik, 33. 6. pp. 1216–1226, Dec. 20, 1910.)—A mathematical discussion of possible extensions of the theory of combination tones and dealing specially with the cases represented by the following equations of motion :—

$$x'' + n_0^2 x + b x'^2 = a \cos pt + d \cos gt,$$

and—

$$x'' + n_0^2 x + b(x'^2 + 2xx'') = a \cos pt + d \cos gt,$$

where dashes denote differentiations with respect to time. [See Abstract No. 832 (1908).] E. H. B.

912. *Combination Tones.* **F. A. Schulze.** (Ann. d. Physik, 34. 4. pp. 817–822, April 7, 1911.)—Discusses the theory of combination tones recently given by C. Schaefer [see preceding Abstract]. E. H. B.

913. *Quality of Musical Sounds.* **K. v. Wesendonk.** (Deutsch. Phys. Gesell., Verh. 13. 6. pp. 278–280, March 30, 1911.)—A discussion as to the theory of the quality of musical tones, in which the work and views of Helmholtz, K. W. Wagner [Abstract No. 441B (1911)], Grassmann, Goldhammer, and Auerbach are noticed. E. H. B.

914. *Sonorous Reproduction of a Periodic Curve.* **S. Lifschitz.** (Comptes Rendus, 152. pp. 401–404, Feb. 13, 1911.)—Discusses on Fourier's theorem the production of the sounds corresponding to a given periodic curve as in a phonographic record. E. H. B.

915. *Two Simultaneous Simple Tones.* **E. Waetzmann.** (Phys. Zeitschr. 12. pp. 231–238, April 1, 1911.)—A mathematical and general discussion of the phenomena occurring when two simple tones (1) of equal amplitude and (2) of equal energy are sounded together. The cases of beats and the generation of combination tones are enlarged upon. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

916. *On the Distribution of Electricity in Equilibrium in Conductors.* **II. E. Almansi.** (Accad. Lincei, Atti, **20**. pp. 150–154, Feb. 5, 1911.)—The author gives in this paper some observations which, he says, enable us to obtain a simple solution of the problem considered in a previous paper [Abstract No. 878 (1911)]. As in the former paper, he supposes three closed surfaces σ, σ_0 and τ, σ_0 being within σ, and the object is, as before, to form a distribution on σ, the force due to which shall at all points in the space S_0 enclosed by σ_0 be less than an assigned limit ϵ. τ is a third surface between σ and σ_0 and having no point in common with either. Also ϕ is the potential of a mass equal to M distributed on τ. It might be distributed arbitrarily, but is supposed to be concentrated at the point Q_0 on τ. From ϕ he derives successively, as in the former paper, $\phi_1 = \phi - ap$, in which a is a constant, and $p = 1/r - 1/r'$, r and r' being the distances of any point in space from those points Q and Q′ of τ where U, the potential of M distributed on the surface σ, has its greatest and least values respectively. That is, $p = h/r - h/r'$. Therefore ϕ_1 is the potential of three masses, M, a, and $-a$. As in the former paper—

$$\Delta = \left(\frac{d}{dx}\right)^2 + \left(\frac{d}{dy}\right)^2 + \left(\frac{d}{dz}\right)^2$$

and—

$$B = \int_S \left(\frac{d\phi}{dx}\frac{dp}{dx} + \frac{d\phi}{dy}\frac{dp}{dy} + \frac{d\phi}{dz}\frac{dp}{dz}\right) dS,$$

and—

$$C = \int p \frac{dp}{dn} d\sigma.$$

Since the two surfaces σ and τ have no point in common, there must exist a finite superior limit of p, and therefore a finite superior limit of dp/dn, dn being an element of the normal for each point on σ, and whatever be the points Q and Q′ on τ. Therefore a finite superior limit, denoted by L, of the quantity C. Now since—

$$\phi_1 = \phi - ap$$
$$\Delta\phi_1 = \Delta\phi - \Delta(ap)$$

and if—

$$A = \int \Delta\phi\, dS, \quad \text{and} \quad A_1 = \int \Delta\phi_1\, dS$$

we have by differentiation—

$$A_1 = A - 2aB + a^2C.$$

Let now the constant—

$$a = B/C.$$

Then—

$$A_1 = A - \alpha, \text{ if } \alpha = 2aB - a^2C = B^2/C,$$

and—

$$A_2 = A_1 - \alpha_1 = A - (\alpha + \alpha_1).$$

Similarly—

$$A_3 = A - (\alpha + \alpha_1 + \alpha_2), \text{ \&c.},$$

and—

$$A_{I+1} = A - (\alpha + \alpha_1 + \alpha_2 \dots + \alpha_I), \text{ I being any integer.}$$

The quantities A, A_1, &c., are all positive, and therefore $\alpha + \alpha_1 + \ldots + \alpha_I < A$. From this it follows that at least one of the I+1 positive quantities α, &c., must be $\leqq A/(I + 1)$. Assume, then, that $\alpha_i \leqq A/(I + 1)$ ...(1), where i represents an integer $\leqq I$. Then as in the former paper $D_i^2 \neq L\alpha_i/16\pi^2 \alpha_i$ ...(2), L being the superior limit of $\int_s \Delta p\, dS$, and D_i the difference between the greatest and least values of the potential of M distributed over σ with density $h_i = -1/4\pi \,.\, d\phi_i/dn$. From (1) and (2) it follows that—

$$(D_i)^2 = LA/16\pi^2(I + 1) \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Instead of calculating the potentials ϕ_1, ϕ_2, &c., the author now considers a single potential Φ, due to $K = 2i + 1$ masses, whose sum is equal to M, situated at K points of the surface τ, and assumes $H = -1/4\pi \,.\, d\Phi/dn$ and seeks to determine the positions of these K masses in order that the force F due to the mass M distributed on the surface σ with density H may be at all points in the space S_0, that is the space within σ_0, as small as possible. For instance, let $i \leqq I$, and therefore $2i + 1 \leqq 2I + 1$. And let us suppose that only $2i + 1$ of the $2I + 1$ masses differ from zero, and that they have the values to which corresponds the density h_i. Let η be a positive number to be defined later, and suppose I to be so great that $(D_i)^2 = LA/16\pi^2(I+1) \leqq \eta^2$. Therefore $D_i \leqq \eta$. Let G_i be the value of the potential U_i at a given point P in the space T, the space enclosed by τ. If ρ be the least distance between the surfaces σ and τ, a sphere of radius ρ may be described wholly within T with any point P as centre. Let the value of U_i at P be G_i, and let the general value of U_i be $G_i + u_i$. Consider the force F at P due to M distributed over σ with density h_i. Then by an elementary proposition in the theory of potentials, the mean value over the ρ sphere of U_i is G_i—or as the author says, G_i can by known methods (he refers to Dirichlet's problem) express F in terms of the values assumed by u_i on the surface of the ρ sphere. Let $F \leqq E\eta$, where E is a function of ρ. Again, let $\eta = \epsilon/E$, that is, $E\eta = \epsilon$. Then the equation (3) becomes (4) $LA/16\pi^2(I + 1) \leqq \epsilon^2/E^2$. Let now $K = 2I + 1$. Then (4) becomes—

$$LA/8\pi^2(K + 1) \leqq \epsilon^2/E^2, \quad \text{or} \quad (4)\ K = (4AE^2/8\pi^2\epsilon^2) - 1.$$

And K may be the least number which satisfies this condition. The solution of the problem requires then, (1) the determination of K; (2) the distribution over τ, which lies between σ and σ_0, of K masses whose sum is M, so that Φ being their potential, and $H = -1/4\pi\, d\Phi/dn$, the greatest possible value of the force F due to the mass M distributed over σ with density H, shall be as small as we please. Therefore at all points within S_0 $F \leqq \epsilon$. S. H. B.

917. *Electrical Dispersion and Potential of the Atmosphere in Tunis during passage of Halley's Comet.* **G. Accolla.** (N. Cimento, 1. Ser. 6. pp. 182–188, Feb., 1911.)—Half-hourly determinations of the electrical dispersion and potential in Tunis during the days of May 16, 19, and 22, 1910, showed the dispersion to be greatest on the 19th, the day of the passage of Halley's comet, and least on the 16th. The fall of potential remained positive throughout the 16th and 22nd, but on the 19th was negative, except the first two observations at 6 and 6.30 a.m. and the three last between 4 and 5 p.m. These results are not attributed to Halley's comet, but in view of other observers' results, must probably be ascribed to wind and other local causes. W. H. Sl.

DISCHARGE AND OSCILLATIONS.

918. *Nuclei produced by Ultra-violet Light.* **S. Sachs.** (Ann. d. Physik, 34. 8. pp. 469–497, March 9, 1911. Inaug. Dissertation, Heidelberg, June 15, 1910.)—The chief results of this research may be briefly stated as follows: (1) The investigation of the carriers of electricity which occur in the air under the action of ultra-violet light shows, in agreement with Lenard's observations, the existence of slowly moving carriers even in dust-free air. (2) Uncharged nuclei were produced by ultra-violet light in the following dry gases: air, CO_2, oxygen, and nitrogen. In hydrogen these nuclei were not detected, and this is explained by its slight absorption of ultra-violet light. Other conjectural matters are also discussed. [See Abstracts Nos. 1028 (1900) and 97 (1901).] E. H. B.

919. *Velocity Dispersion of Canal Rays.* **J. Kutschewski.** (Phys. Zeitschr. 12. pp. 163–164, March 1, 1911.)—Canal rays often show a dispersion of their velocities or a variation of velocity from particle to particle among the swarm. The author formulates the following conclusions for hydrogen canal rays passing into oxygen with speeds between $2 \cdot 1 \times 10^8$ to $4 \cdot 6 \times 10^7$ cm./sec.: The velocity dispersion is conditioned by the phenomena in the discharge space and is more marked for smaller maximum velocities. In the author's observation space of 16 cm., with pressures of about 0·007 mm., the velocities may vary by ± 2 per cent. Under these conditions in oxygen about half the hydrogen canal rays are absorbed. E. H. B.

920. *Transverse Currents in Luminous Discharge.* **R. Reiger.** (Deutsch. Phys. Gesell., Verh. 13. 7. pp. 288–306, April 15, 1911.)—When a wire kathode is partly bathed in a luminous cross-stream of ions between a CaO and Fe electrode, the kathode fall of potential is greatly reduced, especially for small current-strengths. The stronger the luminous current, and the greater the area of the kathode exposed to it, the greater is the reduction of the kathode-fall. This reduction may bring a kathode-fall of 10,000 volts down to even less than 1 volt. The kathodic dark space is being fed with ions which break down its want of conductivity. If the kathode is made an anode, the anode-fall of potential is affected in the like manner and asymptotically approaches the full value as the strength of the main current increases; but the data are complicated by a tendency to increase in anode-fall as the experiments proceed. When both kathode and anode are bathed in the luminous discharge, the discharge between them, transverse to the stream of ions, encounters very little resistance for small voltages, being apparently helped by the influence of the luminous stream of ions to an extent which depends on the strength of the luminous current; but with increasing applied voltages, the current between anode and kathode comes to increase more and more slowly. If, however, the anode and kathode plates be divided into sections, and if there be a space between the walls of the tube and the back of the anode or kathode plates, the current-strength curve is found at a certain voltage to swerve suddenly upwards. Applying a small voltage (say 2 to 12 volts) to the anode and kathode, and varying the current *i* of the luminous discharge, the current I actually passing between the anode and kathode is found to vary as *i*; the ratio I/*i* increases with the voltage applied to the anode and kathode. [See Abstract No. 2992 (1904).] A. D.

921. *Kathodic Corpuscles;* m *as* f(v). **C. E. Guye and S. Ratnowsky.** (Archives des Sciences, 31. pp. 293–321, April, 1911.)—A determination of *m′/m* as between great and small values of v. If the terrestrial magnetic field be compensated, then by adjusting the magnetic and electrostatic fields necessary to produce equal deviations in both slow and rapid rays, we get $m'v'/mv = \mathrm{H}'/\mathrm{H}$ and (practically) $mv^2/m'v'^2 = \mathrm{F}/\mathrm{F}'$. The deviations then become $y = [\mathrm{A}]e\mathrm{V}/mv^2$ or $[\mathrm{A}]\mathrm{GV}'/m'v'^2$ for the electric, where V is the voltage and [A] is the integral of the electric field; and $[\mathrm{B}]mv/e\mathrm{I}$ or $[\mathrm{B}]m'v'/e\mathrm{I}'$ for the magnetic, where [B] is the integral of the magnetic field and I the corresponding exciting current. From these we find $m'/m = \mathrm{VI}'^2/\mathrm{V}'\mathrm{I}^2$ and $v'/v = \mathrm{V}'\mathrm{I}/\mathrm{VI}'$. To compare these results with the theoretical formulæ, we must know v and v' in absolute values. For this we must know [A] or [B] and also e/m. For slow rays if U be the discharge potential and (m) the mass, $\mathrm{U}e = \frac{1}{2}(m)v^2$; whence $[\mathrm{A}] = 2 . \mathrm{U}/\mathrm{V} . m/(m) . y$, where $m/(m)$ is very nearly unity, and e/m is taken at Simon's value, $1{\cdot}878 \times 10^7$. Thus v can be found for these rays; and from the value v'/v above, v' for the rapid rays can be found. Now we can compare the values of m'/m with Lorentz's value $m/m_0 = (1-\beta^2)^{-1/2}$ and Abraham's—

$$m/m_0 = 3/4\beta^2 . \left[\left\{ (1+\beta^2)/2\beta . \log (1+\beta)/(1-\beta) \right\} - 1 \right],$$

where the transversal masses are referred to. The rays examined had velocities up to $1{\cdot}5 \times 10^{10}$; and for these Abraham's formula did not work well and would have done a little less well if the later value $e/m = 1{\cdot}77 \times 10^7$ (Classen and Woltz) had been adopted. The Lorenz-Einstein formula (relativity) did work well; whence another argument in favour of the relativity principle as against Abraham's solid electrons. [See Abstract No. 418 (1910).] A. D.

922. *Radiation emitted in the Interior of Glow-lamps.* **L. Houllevigue.** (Comptes Rendus, 152. pp. 1240–1243, May 8, 1911.)—When glow-lamps with carbon filaments are placed in a circuit on too high a voltage, a bluish glow completely fills the bulb. This glow is of a fleeting nature, rarely continuing more than one minute, although the filament continues incandescent. It is extinguished so much the quicker as the super-voltage is greater. When observed with the spectroscope the principal rays due to mercury are visible. When a magnet is brought near, the glow concentrates itself along the tube of force which passes through the filament. The explanation offered is that electrons emanating from the incandescent carbon ionise the mercury vapour which remains in the bulb, and so produce its spectrum. In the magnetic field these electrons emitted in all directions with small velocities, become enrolled in a helix around a tube of force containing the point of emission. In order to study this phenomenon a 50-volt carbon filament lamp is connected to a Gaede air-pump. The lamp has a closed tube placed laterally so as to face the ring of filament. A diaphragm having an opening 6 mm. diam. is placed at the entrance to this tube. A pressure of less than 0·001 mm. is maintained for some hours, and the voltage is gradually raised to 75 or 80 volts. The glow first fills the bulb, then suddenly traverses the diaphragm, increasing in length until it forms a column of 6–7 cm. The length of this luminous pencil increases with the temperature of the filament and with the degree of the vacuum. A slight entry of air suddenly shortens it, but the gas is gradually absorbed by the filament and the length again increases. All the effects observed with electrostatic fields can be explained by attributing the glow to electrons projected by the filament; but the action of the magnetic field is quite unexpected. This action is never manifested by a deviation: it simply shortens the length of the pencil, whatever may be the direction of the field. Attempts to reproduce the above phenomena with lamps having tungsten filaments have met with no success. **A. E. G.**

923. *Sounds produced in certain Electric Discharges.* **R. De Muynck.** (Annal. Soc. Sci. de Bruxelles, 35. 2. pp. 129–132, 1910–1911.)—In these experiments a Pt-wire 0·025 cm. diam. is stretched horizontally upon insulated supports, 55 cm. apart. This wire is in an electric circuit, and can be raised to incandescence when desired; one of its ends is earthed. Facing this wire there is a brass sphere 1·6 cm. diam., connected to one coat of a battery of 4 large Leyden jars, the other coat of which is earthed. The condenser is in connection with a Holtz machine so that sparks can be produced between the Pt and the sphere. When the distance between these is too great for a spark to be able to pass, unexpected results are obtained: the incandescent wire gives out a clearly perceptible sound. The oscillations are distinctly visible, especially in the dark, when the wire appears as a luminous spindle of a thickness greater than 1 cm. at the middle point. These vibrations are produced whatever the sign of the charge upon the wire, and whatever the form of the other electrode. The sound produced does not appear to be pure; its pitch varies sometimes during the course of the experiment, and always when any change in the temperature of the wire takes place. In the cold the vibrations are not perceptible. It seems that the explanation can be based upon effects due to electrostatic attraction, and the variation of elasticity produced by periodic heating, provided that it is assumed that a loss of electric charge takes place through the incandescent wire. The Pt is attracted towards the sphere, and a partial discharge from the wire takes place; at the same time the wire is cooled somewhat, and as the result of these two processes moves back towards its first position. A new heating occurs, followed by attraction. These phenomena being repeated periodically give birth to vibrations producing sound. Other instances of sounds produced by electric discharges, which have previously been observed by other experimenters, are also discussed. **A. E. G.**

924. *Effect of Early Extinction of Spark on Damping Determinations.* **B. Macků.** (Ann. d. Physik, 34. 5, pp. 941–970, May 9, 1911.)—The theory of the ordinary methods of determining damping in condenser circuits involves the assumption that the spark is not quenched before all the energy is dissipated. In general the spark is extinguished earlier than this. The paper gives both a theoretical and experimental investigation into the manner in which the early extinction of the spark affects the results. The theory shows that it causes such a deformation of the resonance curve that the damping deduced is too great, and that the value of the damping varies with the ordinate at which it is determined. The deformation is greatest when the damping of the measuring circuit is small compared with that of the primary circuit. If the damping in the two circuits is the same, and provided that the spark is not extinguished before the amplitude of the potential has sunk to 7 per cent. of its original value, the deformation ceases and the same value of damping is obtained from the resonance curve at any ordinate. If a change in the damping of the primary circuit be determined by a measuring circuit which is very slightly damped, the result is too high, but is correct if the damping of the measuring circuit is made equal to that of the primary circuit. These theoretical results are confirmed by the experimental results

which are given. It is possible to determine approximately the time at which the spark is extinguished by taking two resonance curves, one with small, the other with greater secondary damping. These results indicate that damping measurements should be made with the damping in the measuring circuit *equal* to that of the primary. T. P. B.

925. *Logarithmic Decrement of a Condenser Circuit.* **A. Petrowsky.** (Lumière Électr. 14. pp. 205-206, May 20, 1911.)—Bjerknes' method of determining the logarithmic decrement δ_1, of a condenser circuit gives the sum of this log. decrement and that of measuring circuit. Instead of calculating the latter the author eliminates it by using two measuring circuits of different log. decrements, δ_2 and δ_3. He thus obtains $\delta_1 + \delta_2$, $\delta_1 + \delta_3$, and, by using one of the measuring circuits as the exciter of the other, $\delta_2 + \delta_3$. The circuit, which acts as the primary in this last case, must be set oscillating by a method by which the log. decrement is not altered. T. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

926. *Sensitiveness of Selenium Preparations.* **A. Pochettino.** (N. Cimento, Ser. 6. 1. pp. 147-210, March, 1911.)—It has not been quite clear whether the changes in resistivity under light are purely photoelectric or depend on a molecular transformation. The existence of allotropic modifications has led to discrepancies in the results. We have had two types of construction: (1) Wires with Se between (Siemens, Bidwell), or films of Se separated by mica (Bell, Mercadier, Majorana), in which the current was at right angles to the light; and (2) a film of Se between two transparent Pt electrodes, in which the current and the light were parallel in their direction. For reasons mathematically developed type (1) is preferable. Methods of ripening the Se are discussed and compared. The sensitiveness diminishes as the voltage or the temperature is increased, and presents a maximum at about −40° C. It also depends in a complicated manner on the colour of the incident light and on its intensity and the rapidity of variations in this, as also on the pressure, on the actual resistance, and on the strength of the current passing, and, further, on the amount of polarisation gradually set up in the cell. Then the author discusses sundry anomalies, including inertia of the cell, which stands at a minimum in cells made according to Gripenburg's method of condensing Se vapour on the cold surface. The laws of cooling of Se are considered, and the two modifications of Se existing in "sensitised selenium." Then the effect of light is molecularly to transform one of these into the other, with alteration of other physical properties at the same time; the transformation being reversible, especially in the presence of traces of metallic selenides. The atmosphere plays no part in this, and the specific sensitive material is the pure selenium itself. Various theories on this subject are discussed, with mathematical developments. The analogous effects of Röntgen rays, radium β-rays, and other ionising rays, as also of practically all radiations or emanations capable of producing photographic effects are considered. [See Abstract No. 1887 (1907).] A. D.

927. *Thermoelectric Properties of Molybdenum; Reflecting Power of Metals.* **W. W. Coblentz.** (Bureau of Standards, Bull. 7. pp. 197-225, May 15, 1911.)—The greater part of the paper is devoted to the reflecting power of metals, and gives at greater length the results of work already dealt with. As regards thermoelectric properties, those of Ta and W were referred to in

Abstract No. 1607 (1909). The molybdenum wire used was 0·627 mm. diam. and about 25 m. long. Copper wires 0·2 mm. diam. were wound tightly around the ends of the Mo-wire and soldered. For the melting-points of zinc and tin the junction was in a thin glass tube. Above 600° the Mo oxidised so rapidly that no measurements were made on its e.m.f. For temperatures as high as 419° (m.p. of Zn) the metal shows no oxidation. The observations were extended to −78·5° (CO_2-snow and ether). Between 0° and 100° Ta and Mo have almost the same thermoelectric power; they are, however, *opposite in polarity*. In a Cu-Ta couple the direction of the current is the *same* as in Cu-constantan, while in Cu-Mo the direction of the current is *opposite* to that of a Cu-constantan couple. Between 0° and 100° the thermoelectric power of the Mo-Cu couple is 4·4, between 100° and 200° it is 6·6, and between 200° and 400° it is 9·8 microvolts per degree. The thermoelectric power, between 0° and 100°, is thus about one-tenth the thermoelectric power of copper-constantan. L. H. W.

928. *Sensitiveness of Moving-coil Galvanometers.* **E. Dibbern.** (Zeitschr. Instrumentenk. 31. pp. 105–112, April, 1911.)—The results obtained by Jaeger [Ibid. 23. pp. 261, 353, 1903, and Abstracts Nos. 2080 (1903), 1685 (1903)] for moving-coil galvanometers were tested experimentally, and it is shown that for the several galvanometers dealt with Jaeger's relations hold good as regards variations of the moment of inertia and of the directive couple. Reinganum [Abstract No. 537 (1909)] proposed to increase the sensitiveness of the moving-coil galvanometer by suspending from the strips carrying the coil, but outside the strongest part of the field, an iron rod, horizontal and perpendicular to the lines of force. In the equilibrium position this rod had little induction through it, but the flux was considerable when the coil was turned, and hence a greater deflection was obtained. In a second method a magnetised steel rod was used with its axis parallel to the field. Both these methods are discussed and experimental tests described. They result in a considerable increase of the current sensitiveness, but the increase of sensitiveness for potential is slower than for current. The use of the magnetised steel rod is preferable to the iron rod method. A. W.

929. *Electrical and Mechanical Properties of Alloys of the Noble Metals.* II. **W. Geibel.** (Zeitschr. Anorg. Chem. 70. 3. pp. 240–254, April 10, 1911.)—The author has continued the study of the electrical conductivity, temperature coefficient, thermo-e.m.f., and tenacity [see Abstract No. 139 (1911)] of the Pd-Au alloys to other alloys of the noble metals. *Palladium-silver* alloys are all ductile and give curves similar to those of the Pd-Au alloys, the minimum of the electrical properties being at 40 atoms per cent. Ag, while the max. strength occurs at 50 atoms per cent. Ag. An alloy containing 40 atoms per cent. Ag has an extraordinary low temperature coefficient. *Palladium-platinum* alloys have not been studied thermally, but the present results indicate that they form a continuous series of solid solutions. Compared with the first two series the alloys are not very ductile, the max. hardness being at 56·2 atoms per cent. Pt, while the minimum on the conductivity curve is at 46 atoms per cent. Pt. The thermal e.m.f. curves are very interesting; all the alloys are + against Pd, and with the exception of the alloy containing 10 per cent. Pt, also + against Pt. Between 10 and 40 atoms per cent. Pt the temperature coefficient of the thermal e.m.f. becomes negative at high temperatures. Above 1100° C. the thermal e.m.f.-concentration curve shows a maximum at 35·3 atoms per cent. Pt. *Platinum-Iridium.*—Pure Ir is hard and very brittle and makes Pt harder and so difficult to work that the practical limit of utility is attained at 40 atoms per cent. Ir. The author has investigated the alloys up to 85 atoms per cent. and his results indicate the existence of a continuous series of solid solutions. The thermo-e.m.f. of all the alloys is + against Pt and attains a maximum between 20 and 80 per cent. Ir, according to the temperature. At high temperatures it is liable to change owing to the volatility of Ir. Experiments on the effect of annealing temperature on the alloys indicate that while the lower Ir alloys (up to 10 per cent.) become softer as the temperature of annealing is increased the higher alloys at first become harder—*e.g.*, a 25 per cent. alloy has a strength of about 92 kg. when drawn, 105 kg. after annealing for half an hour at 750° C., and 70 kg. after annealing at 1860° C. At the same time the elongation increases continually, attaining a maximum between 900 and 1100° C. *Platinum-gold* alloys were investigated only up to 40 per cent. Pt, the higher alloys being difficult to work. The thermo-e.m.f. is negative against Pt and increases with the Pt-content. Measurements could only be made with difficulty, because with each repeated heating the thermo-e.m.f. became more and more negative. *Platinum-silver* alloys were investigated up to 88 atoms per cent. Pt. The thermo-e.m.f. depends on the time of heating, but becomes constant after heating for two hours at 700 to 800° C. Like the Pt-Ir alloys, the strength at first increases with the temperature of annealing, but attains a maximum at 400° C.

F. C. A. H. L.

930. *Effects of Sudden Changes of Inductance and Certain Mechanical Analogies.* **B. O. Peirce.** (Amer. Acad., Proc. 46. No. 20. pp. 541–585, April, 1911.)—A few simple problems are first discussed which illustrate the effects produced in a circuit by sudden changes in the inductance when no magnetic material is in the neighbourhood. When metal cores are present the action of the eddy currents tends to mask the characteristic effects produced. The author has devised many mechanical analogies to illustrate these effects. It is known that the final flux of magnetic induction through a solid iron core is not determined by the excitation alone even when its initial magnetic condition is given; it depends upon the manner of the application of the given excitation, being in some cases quite different when the excitation is applied suddenly in small steps at a time from what it is when the excitation is applied continuously. The reasons for this are given. Oscillograms are shown also to illustrate the rise of the current in the coils of electromagnets.

A. R.

931. *Zinc Amalgams and the Clark Cell.* **E. Cohen and P. J. H. van Ginneken.** (Zeitschr. Phys. Chem. 75. 4. pp. 487–498, 1910.)—The zinc-mercury melting-point diagram is investigated and discussed in detail and the results are given of many measurements on the electromotive behaviour of zinc amalgams. According to these measurements the temperature formulæ for the Clark cell, hitherto recommended, cannot be used for precision purposes. Furthermore, any one temperature formula does not cover the range 0°–88° C., but one can be chosen from 0°–20° and a second one from 20° to 88° C.

F. E. S.

932. *Mercurous Sulphate and Standard Cells.* **P. J. H. van Ginneken.** (Zeitschr. Phys. Chem. 75. 6. pp. 687–709, 1911.)—The part played by the mercurous sulphate as depolariser in Weston and Clark standard cells has been investigated by Hulett [see Abstract No. 136 (1909)] and the present paper, in dealing very exhaustively with the theory of the cells, indicates that the whole of Hulett's theory is not in accordance with the facts. For the possible interactions between the mercurous sulphate and the other ingredients of the cell the original paper should be seen. The author thinks it rather premature to pronounce an opinion on the reliability of the Weston cell as a standard, but is inclined to believe that the presence of a small quantity of free acid would be beneficial. This would, however, slightly affect the e.m.f. **F. E. S.**

933. *New Form of Earth Inductor.* **J. E. Ives and S. J. Mauchly.** (Phil. Mag. 21. pp. 579–583, April, 1911.)—Instead of revolving the coil as in the ordinary form of earth inductor, the principle of the slider moving along conducting rails is used. A square frame, of one metre side, is made of brass tubing, and the rail has two guides which rest on the tube and make contact with it. The square is horizontal, so that for a given movement of the slide a known area is described and a magnetic flux VA is cut, where V is the vertical component of the earth's field. This produces a throw on the ballistic galvanometer in series with the square conductor. The galvanometer is calibrated by starting or stopping a known current in a wire running round the square and inside the brass tube. The self-inductance of the square is calculated, and therefore the flux for a given current is known. By placing the plane of the square vertically and at right angles to the magnetic meridian the horizontal component of the earth's field can be found. **S. G. S.**

ALTERNATING CURRENTS AND MAGNETISM.

934. *Resistance and Self-induction of Coils for Alternating Current. I. Coils with One Winding Layer.* **A. Esau.** (Ann. d. Physik, 34. 1. pp. 57–80, Dec. 30, 1910. Dissertation, Berlin.)—The author first considers the general problem of finding the resistance and self-induction of a solenoid, and considers the special cases in which the sections of the wire are respectively in the form of an ellipse and a rectangle. He shows that the approximate formula of Sommerfeld is given by the method of Wien. It can be extended to a solenoid, the wires of which are at a finite distance apart, and he shows that the increase in resistance for frequencies up to 6000 per sec. is correctly obtained. The ratio of the alternating-current resistance W to the direct-current resistance W_0, decreases somewhat as the radius of the solenoid is diminished. Some other results of the author's work are: (1) The decrease in coefficient of self-induction can be represented by the corrected formula of Coffin. (2) With increase in the pitch of the solenoid the decrease in the coefficient of self-induction becomes smaller for both types of cross-section. This decrease is less for a circular than for a square section. (3) Wien's method can be used to calculate the first correction term for the rise in resistance for any chosen section of wire on the assumption that the lines of force are straight. (4) The corrected formula of Picciati seems to represent correctly the increase in resistance for solenoids with wire of circular cross-section. **W. C. S. P.**

935. *Resistance and Self-induction of Coils for Alternating Current. II. Coils of Several Layers of Windings.* **A. Esau.** (Ann. d. Physik, 34. 1. pp. 81–94, Dec. 30, 1910.)—In order to decide to what extent the formulæ of Wien for the increase in resistance may be applied to wires of round section, the author makes a series of experiments on coils with various numbers of layers of windings. The experimental methods adopted were the same as in the case of the previous work [see preceding Abstract]. He finds that the resistance of long solenoids of wire with square section can be calculated by Wien's method, and within certain limits agrees with Sommerfeld's expression. This also applies to the measurement of the effective resistance of flat coils. Wien's formulæ for circular wire give correctly the increase in resistance up to a value of *a* equal to about 8. The agreement between the observed and calculated values is better, the greater the number of winding layers. For long solenoids of square axial section, the formula holds, if we take into consideration the higher powers of $r_1 \times r_2/C$ where r_2, r_1 are the inner and outer radii respectively, and C is the length. The percentage decrease in self-induction is much smaller for long solenoids than for flat coils; it is also inversely proportional to the number of layers. For further particulars the original should be consulted. W. C. S. P.

936. *Resistance and Self-induction of Coils for Alternating Current.* III. *Influence of Damping on Resistance and Self-induction.* **A. Esau.** (Ann. d. Physik, 34. 3. pp. 547–564, March 9, 1911.)—Barton has shown that the resistance and self-induction of a straight wire for damped vibrations are greater than the values calculated from Rayleigh's formula for undamped vibrations [Abstract No. 1161 (1899)]. The author has considered the corresponding problem in the case of a solenoid with wire of square section, and puts forward approximate formulæ for slow and rapid vibrations. He shows that for slow vibrations the resistance increases under the influence of damping, whereas for rapid vibrations it decreases. For slow vibrations the self-induction decreases with the frequency to a less extent when damped than when undamped; the self-induction is greater, equal to, or less than the limiting value for infinitely slow vibrations, according to the extent of the damping and the frequency and the size of the wire. Somewhat similar results were obtained for rapid vibrations. W. C. S. P.

937. *Electromagnetic and Thermomagnetic Effects in Soft Iron.* **E. H. Hall and L. L. Campbell.** (Amer. Acad., Proc. 46. No. 23. pp. 625–668, April, 1911.)—The paper deals with the Hall, Ettingshausen, Nernst, and Leduc effects and the longitudinal effects in iron. The transverse effects are described and defined and their coefficients are given a descriptive nomenclature, *e.g.*, the Hall-effect coefficient is called ${}_eT_e$, the initial *e* indicating that the longitudinal current is electrical, the T that the observed effect is transverse, and the final *e* that this transverse effect is electrical. The other coefficients are denoted by ${}_eT_h$, ${}_hT_e$ and ${}_hT_h$. Measurements of the four coefficients and of their temperature coefficients through a small range were made in a plate of soft iron for which the electrical conductivity, the Thomson-effect coefficient, and the thermoelectric height relative to copper were known. Moreau's formula, connecting the Hall and Nernst coefficients, viz., ${}_eT_e/\rho = {}_hT_e/s$, where ρ is the specific resistance and s the mechanical equivalent of the Thomson coefficient, was tested to see whether the isothermal lines of the longitudinal thermal flow are, in a field of given strength, rotated in the same direction and to the same extent as the equipotential lines of a longitudinal electric flow. The direction is the same in the two cases, but the equipotential lines are rotated about 1¼ times as far as the isothermal lines, this ratio remaining nearly constant through the range of temperature considered, 20° to 100°. Voigt's formula, in which the thermoelectric height of lead relative to the metal takes the place of *s* in Moreau's formula, was also tested. Like the Moreau formula, it seems to be correct at one temperature, and to be untrue at other temperatures. The longitudinal effects whose coefficients are denoted by ${}_{3}L_{4}$ and ${}_{4}L_{3}$ were observed, but there was uncertainty as to the existence of the other two. [See also Abstract Nos. 1470 (1905), and 881 (1907).] G. E. A.

938. *Magnetic Properties of Fluorine.* **P. Pascal.** (Comptes Rendus, 152. pp. 1010–1012, April 10, 1911.)—The mean atomic susceptibility of fluorine, deduced from determinations of the molecular susceptibilities of fluorbenzene and *p*-fluorphenetol, is $-6{\cdot}5 \times 10^{-7}$. Fluorine appears to be diamagnetic, its specific susceptibility, taking that of water as $-7{\cdot}5 \times 10^{-7}$, being $-8{\cdot}447 \times 10^{-7}$. This does not satisfy the exponential law connecting susceptibility with atomic weight, but is approximately a multiple of $-0{\cdot}2468 \times 10^{-7}$, which was also found to be a factor of the specific susceptibilities of Cl, Br, and I [Abstract No. 794 (1911)]. Compounds having several atoms of fluorine attached to the same central atom behave similarly to analogous compounds with the other halogens (*loc. cit.*), but fluorine derivatives containing an oxygen atom near the fluorine atom, such as butyl and benzyl fluorides, are abnormal, the doubly linked oxygen being in these compounds diamagnetic. The discontinuous structure of the halogen atom is confirmed by other physical properties, *e.g.*, molecular volume, and refractive and specific rotatory powers. W. H. St.

939. *Origin of Magnetic Storms.* **A. Schuster.** (Roy. Soc., Proc. Ser. A. 85. pp. 44–50, March 14, 1911.)—After examining the problem analytically, it is concluded that magnetic storms cannot be due to a direct magnetic action of swarms of electrified particles. Taking the modified theory of Birkeland, however, it may be that the magnetic action of the earth in drawing inwards the stream of particles would produce certain of the effects observed. Nevertheless it appears that from considerations of the energy and electrostatic effects involved the original theory is untenable. The only way to reconcile the known phenomena would then seem to be that the particles act by increasing the ionisation of the outer regions of the atmosphere, and allow the electromotive forces which are always present locally to increase the intensity of the electric circulation. Thus the rotation of the earth would then be the source of the energy. Birkeland's idea that the aurora borealis is due to impact of projected particles would still be tenable. C. P. B.

ELECTROPHYSIOLOGY AND ELECTROTHERAPEUTICS.

940. *Advantages and Disadvantages of the Wehnelt Interrupter in Radiography.* **Marie** and **Durand.** (Archives d'Él. Médicale, 18. pp. 1039–1042, Dec. 25, 1910.)—The chief drawback—the great amount of heat produced at the break—is overcome by the authors by the employment of a large wooden containing vessel, lined with lead, which serves as kathode, the capacity of the vessel being 25 to 80 litres. With this quantity of electrolyte the break can be run continuously for a whole morning. The inverse wave is also more difficult to get rid of than with mercury interrupters, and more careful adjustment is required to avoid metallisation of the tubes. The advantage which the Wehnelt break possesses is the capability of giving a very high output. The secondary output is increased by reason of the high rate of interruption;

but as the interruptions are so exceedingly rapid, the secondary voltage is somewhat reduced, owing to there not being time for it to reach its max. value. A coil of longer spark-length is thus required for the operation of the Wehnelt break, and the wire of the secondary winding should not be less than 0·2 mm. diam. L. H. W.

REFERENCES.

941. *Motion of Electrons in Metals.* **J. Ishiwara.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 2. pp. 15–34, Feb., and 6. 3. pp. 36–46, March, 1911.)—Mathematical theory of the motions of electrons in metals, including a treatment of the electric and thermal currents. E. H. B.

942. *Electric Conductivity for Oscillating Forces on the Electron Theory.* **J. Ishiwara.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 4. pp. 56–65, April, 1911.)—The calculation indicated in the title is carried out by two methods, the starting-point being the work of H. A. Wilson on the electron theory applied to the optical properties of metals. [See preceding Abstract and No. 224 (1911).] E. H. B.

943. *Isolation of an Ion, a Precision Measurement of its Charge, and the Correction of Stokes's Law.* **R. A. Millikan.** (Phys. Rev. 32. pp. 349–397, April, 1911.)—The full paper corresponding to Abstract No. 1745 (1910).

944. *Accelerated Motion of a Dielectric Sphere.* **J. W. Nicholson.** (Phil. Mag. 20. pp. 828–835, Nov., 1910.)—[See Abstract No. 1764 (1910).]

945. *Damping of the Vibrations of a Dielectric Sphere, and Radiation from a Vibrating Electron.* **J. W. Nicholson.** (Phil. Mag. 21. pp. 438–446, April, 1911.)—Supplementary to the papers dealt with in Abstracts Nos. 1764 (1910) and the preceding Abstract. Devoted to an examination of the rate of decay of the free vibrations of a movable dielectric sphere in the general case in which its motion starts from rest and is not large at any instant considered. L. H. W.

946. *Apparent Discrepancies in Recent Work on e.* **R. A. Millikan and H. Fletcher.** (Phys. Zeitschr. 12. pp. 161–163, March 1, 1911.)—A discussion of Ehrenhaft's work and their own on the determination of *e*. The present authors now reduce their first value by 2 per cent., thus bringing it down to $4{\cdot}891 \times 10^{-10}$. [See Abstracts Nos. 1270 (1909), 1745 (1910), and next Abstract.] E. H. B.

947. *Electronic Charge.* **F. Ehrenhaft.** (Phys. Zeitschr. 12. pp. 261–268, April 1, 1911.)—Defends his methods and conclusions that $4{\cdot}9 \times 10^{-10}$ e.s. c.g.s. unit is *not* the value of *e*, the smallest electric charge of nature. The paper is chiefly in reply to E. Regener and to R. A. Millikan and H. Fletcher [see preceding Abstract]. E. H. B.

948. *Ionisation of the Atmosphere due to Radio-active Matter.* **A. S. Eve.** (Phil. Mag. 21. pp. 26–40, Jan., 1911.)

949. *Visual Sensations produced by an Alternating Magnetic Field.* **S. P. Thompson.** (Electrician, 65. p. 27, April 15, 1910. Abstract of paper read before the Royal Society.) **A. A. Campbell-Swinton.** (Electrician, 65. p. 76, April 22, 1910.) **K. Dunlap.** (Science, 33. pp. 68–71, Jan. 13, 1911.) **J. B. Whitehead.** (Electrician, 66. p. 1033, April 7, 1911. Abstract of paper read before the Baltimore Section of the Amer. Inst. Elect. Engin.)

950. *Theory of Three Coupled Oscillatory Circuits.* **B. Mackû.** (Jahrbuch d. Drahtlosen Telegraphie, 4. pp. 188–195, Dec., 1910.)—Mathematical.

951. *An Electrolytic Detector.* **J. E. Ives.** (Jahrbuch d. Drahtlosen Telegraphie, 4. pp. 112–117, Sept., 1910. Phys. Zeitschr. 11. pp. 1181–1183, Dec. 8, 1910.)—Notes on a detector consisting of two silver wires, in contact at one spot, and immersed in dilute KI solution, an external p.d. being applied. L. H. W.

952. *Two New Types of Magnetometers.* **J. A. Fleming.** (Terrestrial Magnetism, 16. pp. 1–12, March, 1911.)—The magnetometers (a theodolite magnetometer and a universal magnetometer) here described and illustrated were made by the Carnegie Institution of Washington. L. H. W.

953. *New Apparatus for Radiology for any kind of Current.* (Archives d'Él. Médicale, 19. pp. 265–267, March 25, 1911.)—The very compact apparatus described, which is made by the firm of Malaquin and Dutertre, of Paris, comprises a mercury interrupter for gaseous dielectric, a driving motor which can be actuated off direct or alternating current, and a rotating commutator for rectifying the discharges through the tube, driven by the same motor. L. H. W.

954. *Table for Calculating the Mutual Inductance of Two Parallel Coaxial Circles.* **H. Nagaoka.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 3. pp. 47–51, March, 1911.)—In connection with his recent papers the author gives a further *q*-series formula for computing the mutual inductance of two parallel coaxial circles [see Abstract No. 666 (1911)]. Tables are also given which enable the computation to be made very rapidly. A. R.

955. *Iron Cylinder in a Homogeneous Magnetic Field.* **O. Grotrian.** (Ann. d. Physik, 34. 1. pp. 1–56, Dec. 30, 1910.)—An experimental investigation of the application of the method of determining the distribution of magnetic induction in the interior of the magnetised mass [see Abstract No. 1414 (1907)]. L. H. W.

956. *Supposed Propagation of "Equatorial" Magnetic Disturbances with Velocities of the Order of 100 Miles per Second.* **C. Chree.** (Phys. Soc., Proc. 23. pp. 49–57, Dec., 1910.)—Bauer concludes that Faris' figures [Abstract No. 1338 (1910)] demonstrate the truth of his theory that disturbances normally are propagated round the earth, sometimes eastward, sometimes westward, the time of a complete revolution averaging about 8⅔ min. The author of the present paper discusses the weaknesses of Bauer's theory [see Abstract No. 998 (1910)]. L. H. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

957. *Density of Niton ("Radium Emanation").* **R. W. Gray and W. Ramsay.** (Roy. Soc., Proc. Ser. A. 84. pp. 536–550, Jan. 26, 1911. Chem. News, 103. pp. 85–88, Feb. 24, and pp. 99–101, March 3, 1911.)—The paper gives a more detailed account of the experiments described in Abstract No. 1520 (1910). The balance used for the weighing of the niton (RaEm) was sensitive to 2 micro-mgm. and acted on the same buoyancy principle as that of Steele and Grant [Abstract No. 1988 (1909)], several modifications, however, being introduced. Full details are given of five experiments to determine the atomic weight of niton (RaEm), the mean result being 223. An experiment was also made to determine (by weighing) the amount of He produced by the niton and its products on complete disintegration to RaD, and the result was in good agreement with the disintegration theory although about one-fourth of the He had entered the walls of the weighing tube and had to be expelled by heat and subsequently weighed. The experiments thus afford further proof of the disintegration theory on which the atomic weight of niton should be 222·4 (Ra 226·4—He4), and that niton (RaEm) should lose 3 atoms of He on decay to RaD; *i.e.*, one each from Nt, RaA, and RaC. E. M.

958. *Separation of Ionium and Actinium from Residues.* **B. B. Boltwood.** (Roy. Soc., Proc. Ser. A. 85. pp. 77–81, March 14, 1911.)—The paper deals with the chemical separation of ionium and actinium from certain "actinium" precipitates separated from 500 kg. of pitchblende residues purchased by the Royal Society. An Ac-containing material was separated, of about 20,000 times the activity of uranium oxide, and in amount equivalent to the quantity of Ac in equilibrium with 80 mgm. Ra in a radioactive mineral. 1·8 cm. of thorium oxide containing ionium was separated with an activity about 8000 times that of an equal quantity of uranium oxide. This was determined by the scintillation method to be the amount of ionium in equilibrium with 5·8 mgm. Ra. The amount of He produced by the ionium was measured, and found to be of the same order as that predicted by theory. E. M.

959. *Relation between Viscosity and Atomic Weight for the Inert Gases, with application to Radium Emanation.* **A. O. Rankine.** (Phil. Mag. 21. pp. 45–58, Jan., 1911.)—The author has calculated the viscosities of Ar, Kr, and Xe at their critical points by extrapolation by Sutherland's formula from the values obtained in his previous experiments [Abstracts Nos. 888, 1387 (1910)]. The squares of the values obtained are found to be proportional to the atomic weights. This relation is therefore used to obtain the critical point of Ne, which is calculated to be 61·1° abs. Using the same relation, the viscosity of RaEm is calculated to be $2{\cdot}130 \times 10^{-4}$ at 0° C., taking the values 222° and 377° abs. for its atomic weight and critical point [Ramsay and Gray, Abstract No. 1520 (1910)]. From this, by comparison with the viscosity of He, the ratio of the molecular volumes of RaEm and He becomes 16·97, or 7·16 with Sutherland's correction. Tables are given of the molecular constants of the various inert gases. E. M.

960. *Temperature Measurements in an Experimental Carborundum Furnace.* **H. W. Gillett.** (Journ. Phys. Chem. 15. pp. 213–305, March, 1911.)—Gives a long account of experimental work done on a small carborundum furnace, with special reference to the temperatures attained, the methods of measuring these temperatures, and the calibration of the pyrometers used. The composition of the charge for the carborundum furnace was first studied, and an excess of carbon found advisable. A form of double tube for temperature measurement by optical and radiation pyrometers has been devised which minimises fume trouble. The use of carborundum tubes for this purpose has been introduced, and used up to a temperature of 2800°, gentle suction being employed to sweep out fumes. The mechanical properties of these tubes have been briefly studied, as have also the variables affecting them; the cooling effect of the current of air used to suck out the fumes was found to be negligible, and the corrections for the temperature drop through the graphite plug were determined. This tube has been found to give practically black-body radiation, both for optical and radiation pyrometers. The Wanner pyrometer has been made more sensitive at very high temperatures by the use of a dark glass, a sensitiveness of 10° being obtained up to 2600°. The calibration of the Morse thermo-gauge has been examined, full details of the work being given. A special form of Thwing pyrometer for use with a small field with a high degree of accuracy and for very high temperatures was examined. All three pyrometers mentioned above were calibrated against a spectrophotometer on the basis of Wien's law. Data have been obtained indicating the value 14,200 for the constant C_2 in Wien's law. The Wien and Stefan-Boltzmann laws have been found in agreement up to 2500°. The temperature of formation of siloxicon has been determined as 1540° ± 30°, that of carborundum as 1820° ± 20°, and the decomposition temperature of carborundum to graphite as 2220° ± 20°. It has been shown that "amorphous carborundum" is probably not formed in the commercial furnace, and the influence of the formation of graphite round the core, by the decomposition of carborundum, on the temperatures attained in the furnace, is discussed.

C. O. B.

961. *Reducing Electric Smelting of Oxidic Ores—Titanium-Iron Ore.* **W. Borchers.** (Metallurgie, 8. pp. 246–248. April 22, 1911.)—The reducing smelting of mixtures of ore and carbon in the electric furnace is inefficient, because the slag separates the oxide from the reducing agent. In the case of titanium-iron ore the smelting can, by insufficient addition of carbon, be so conducted that a mixture of titanides and carbonides remains in contact with the oxide. The smelting is carried on in two furnaces. In the one the ore is fused; in the other (electric resistance furnace) the fused mass is smelted with carbon and slag. Thus iron and titanium slag are gained. H. B.

962. *Alteration of Aluminium.* **H. Le Chatelier.** (Comptes Rendus, 152. pp. 650–652, March 13, 1911).—The spontaneous alteration of pressed sheet aluminium vessels has received considerable attention of late [see Abstract No. 550 (1911)], and the author has examined microscopically a number of sound and disintegrated aluminium camp vessels. Apparently the disintegration is intimately bound up with the development of an open cellular structure, the metallic grains becoming separated either by chemical or mechanical action. Laboratory experiments indicate that the presence of small quantities of calcium greatly facilitates this opening-out of the structure.

F. C. A. H. L.

963. *Adhesivity of Brown Gold.* **Hanriot.** (Comptes Rendus, 152. pp. 369–372, Feb. 13, and pp. 704–706, March 13, 1911.)—When two plates of brown gold [see Abstract No. 551 (1911)], heated below the temperature at which they change into ordinary gold, are placed in contact, they become joined one to the other, a phenomenon which the author terms "adhesivity." This property is not electrical or magnetic, nor is it due to softening of the metal by heat, since the plates adhere even some time after completely cooling. A plate of brown gold will, after heating, adhere to a plate of yellow gold, or to another one of brown gold, if the latter has been also heated. The minimum temperature to which the heating must be carried is 800° C., and repeated heating and cooling destroys the effect. When the action has ceased at one part of a plate, it may still be observed at other parts. Brown gold differs from ordinary gold not only in colour, fragility, and adhesivity, but also in density, magnetic power, and other physical and chemical properties, and is evidently a distinct variety of gold, dimorphous with, or an allotropic modification of, ordinary gold. Adhesion only occurs between plates of the two different varieties, and the contraction which takes place in brown gold when heated [see Abstract No. 551 (1911)] is attributed to this adhesion. Platinum possesses a similar property. W. H. St.

964. *Metallic Titanium.* **M. A. Hunter.** (Rensselaer Polytechn. Inst., Eng. and Science Series, 1. pp. 1–9, 1911.)—The author succeeds in preparing almost pure titanium by reducing titanium tetrachloride with sodium, the reduction being effected in a closed steel cylinder (Nilson and Petersson). For this purpose titanium chloride, obtained by the chlorination of approximately pure titanium carbide, was re-melted in a current of nitrogen, and subsequently repeatedly distilled, the end fractions being rejected. The fraction boiling between 136° and 137° was shaken repeatedly with mercury and sodium amalgam and finally again distilled (B. P. 136·5° C. uncorrected). The reaction, which is almost instantaneous, is started by heating the bomb to a low red-heat. Subsequently, on leaching the product with water, titanium alone remains, partly as a grey powder, but mostly in the form of fused globules which, on analysis, prove to be pure Ti with no trace of Na or Fe. Two analyses on one of these globules, by separate investigators, gave Ti 99·9 and 100·2 per cent. respectively. In this way, from 500 gm. of titanium chloride and 245 gm. of sodium, a yield of 90 per cent. of the theoretical value was obtained, some of the metal having been oxidised undoubtedly, either by the sodium, which always contains oxygen, or by the water in the subsequent leaching. The pure metal, although hard and brittle in the cold, may be forged at a low red heat into small rods. The melting-point of pure Ti, determined electrically by heating a rod of this nature in a vacuum by means of an incandescent filament, lies between 1800° and 1850° C., and is certainly not greater than 1850° C. Finally, for the specific heat, the author obtains values varying between 0·1462 for a temperature range of 0–100° and 0·1568 for a range of 0–338° C. As to the reduction of titanifluorides by the alkali metals, the product obtained by the author never contained more than 78·0 per cent. Ti; whilst the reduction of titanium oxide with carbon yields merely a varying mixture of the lower oxide and carbide. C. A. W.

965. *Amalgams containing Silver and Tin.* **R. A. Joyner.** (Chem. Soc., Journ. 99. pp. 195–208, Feb., 1911.)—Describes an investigation of the chemistry and physical chemistry of the ternary system—Sn-Ag-Hg, which is interesting from a purely scientific point of view and also from a practical point of view, as these amalgams are largely used in dental practice. A thorough revision of the Sn-Ag system was first undertaken, and it was found that no compound other than Ag_3Sn exists. The next point was to investigate the phenomenon of ageing of these alloys, for it has been found by G. V. Black that fresh filings of Sn-Ag alloy require half as much mercury again for amalgamation as similar filings which had been kept several months, or which had been heated for half an hour to 100°. In order to confirm the existence of, and to determine the extent of "ageing," a quantity of filings (4 gm.) was shaken with excess of Hg for 2 min. and then the excess of Hg was squeezed through a small bag of chamois leather by a 56-lb. weight applied through a piston in a cylinder 20 cm. in diam. From the experiments it was found that "aged" filings retained only half the amount of mercury that the "non-aged" filings did, namely, 0·41 instead of 0·88 of their weight. A table is given showing the amount of mercury retained by aged and non-aged filings. Experiments are described which were carried out with a view of testing various hypotheses in regard to the nature of ageing, and the conclusion is drawn that ageing is a property of the Ag_3Sn compound contained in the alloys, and a fine state of division is essential for its occurrence, also that the phenomenon is due to polymerisation of the Ag_3Sn. Experiments are also described on the hardening of Sn-Ag amalgams, which prove that a chemical reaction takes place, resulting in the breaking up of the compound Ag_3Sn in order to form the compound Ag_3Hg_4, leaving all the tin in the free state and causing the hardening. C. O. B.

966. *Occlusion of Hydrogen by Palladium-Gold Alloys.* **A. J. Berry.** (Chem. Soc., Journ. 99. pp. 463–466, March, 1911.)—Alloys containing 80 to 100 per cent. Pd were prepared, and the occlusion measured by making the alloy act as kathode in a voltameter containing dilute sulphuric acid. It was found necessary to previously anneal the alloys for 2 hours at 650° C. in order to get consistent results, the amount of gas absorbed depending largely on the physical condition of the surface of the metal. The results show that the occluding power of these alloys is a simple function of the Pd-content though not simply proportional to it. An alloy containing 19·5 per cent. Pd did not occlude any hydrogen. F. C. A. H. L.

967. *Gold-Tellurium Alloys.* **M. Coste.** (Comptes Rendus, 152. pp. 859–862, March 27, 1911.)—Some twenty mixtures of specially purified Au and Te, in different proportions, have been heated to fusion for 1 hour in sealed tubes, and the polished surface of the cooled alloys microscopically examined. Two separate constituents are visible for all mixtures except that corresponding in composition to the formula $AuTe_2$. This compound forms eutectics with both Au and Te, but no compound corresponding to Au_2Te has been obtained. Measurements of the e.m.f. of solution of the alloys in dilute nitric acid confirm the existence of only one compound, $AuTe_2$, this being slightly less than, or equal to 0·55 volt for all alloys containing 43·61 per cent. or more Au, and 0·65 volt for all alloys containing less than 42 per cent. Au. W. H. Si.

968. *Silver-Cadmium Alloys.* **G. J. Petrenko and A. S. Federow.** (Zeitschr. Anorg. Chem. 70. 2. pp. 157–160, March 6, 1911.)—The investigation of this series was undertaken because of the interest arising from the fact that the alloys of Ag with Mg and Zn, analogues of Cd, and the alloys of

Cd with Cu and Au, analogues of Ag in the periodic system, have already been investigated [see Abstracts Nos. 978, 1817, 1478, and 1799 (1906)]. Thirty-four alloys were prepared from Kahlbaum's pure metals and their cooling curves taken along with those of the pure metals, the results being subsequently confirmed and extended by microscopic analysis of slowly cooled and quenched samples of the alloys. The authors found that Ag is sensibly volatile in the presence of Cd at temperatures considerably below 900° C. The liquidus drops from the melting-point of Ag to that of Cd with no maxima, but consists of seven branches corresponding to the separation of the solid solutions α (Ag-rich), β, γ, δ, ε, and η (Cd-rich), while between 7 and 19 per cent. Ag it seems probable that the compound $AgCd_4$ separates. There is also a possibility of the existence of the compounds $AgCd_3$ (γ solid solution) and Ag_2Cd_3 (ε solid solution). Alloys corresponding to the latter composition are rose-coloured and very brittle, and such a compound would be quite analogous to the compounds Ag_2Zn_3 and Cu_2Zn_3. Between 89 and 64 per cent. Ag the alloys undergo two changes in the solid, one at 426° corresponding to the breaking up of the β solid solutions into the saturated solutions α and γ, and the other at 200° C. corresponding to the interaction of the α and γ solid solutions with the formation of the compound AgCd. Bruni and Quercigh's results [see Abstract No. 161 (1911)] showed a continuous series of solid solutions between 19 and 100 per cent. Ag, this being the principal difference between their results and those of the present investigation. Eight photomicrographs accompany the paper.

F. C. A. H. L.

969. *Decomposition of Calcium Carbide by Heat.* **G. Erlwein, C. Warth** and **R. Beutner.** (Zeitschr. Elektrochem. 17. pp. 177–179, March 1, 1911.)—Commercial calcium carbide is decomposed by heat already below 1000° C. The carbide turns black and there is a liberation of carbon and probably formation of subcarbide (suboxide?), but no reduction to calcium. The heated product finally does not any longer generate acetylene, nor does it liberate hydrogen (which would indicate the presence of metallic Ca), but continues to bind nitrogen to cyanide. When the commercial carbide is heated without any addition and in a hydrogen atmosphere, the decomposition proceeds gradually and is not noticeably accelerated above 1000° C. In the presence of 10 per cent. CaF_2 (also of $CaCl_2$, NaCl, iron filings, &c.) the decomposition is more rapid, and particularly more rapid when the temperature of 1000° C. is exceeded; when the experimenters went up to 1250° C. the decomposition was complete in 3 hours.

H. B.

970. *Precipitation of Free Carbon from Iron-Carbon Alloys.* **W. H. Hatfield.** (Roy. Soc., Proc. Ser. A. 85. pp. 1–18, March 14, 1911.)—Deals with the chemical physics involved in the precipitation of free carbon from the alloys of the Fe-C system. In the author's opinion, the double diagram based on the assumption of a metastable and a stable equilibrium is inaccurate, since, in the liquid or the solid state, that carbon which is in solution is contained therein as carbide. Experiments are described and illustrated by photomicrographs, which afford evidence that the carbide must separate out from solution before free carbon can appear, and that it is only the structurally free carbide that can dissociate; free carbon will not separate from solid solution. The influence of Si, S, and Mn upon the precipitation are found to be as follows: (1) The Si (if it be the only foreign element present) is not uniformly distributed through the material. The carbide, whilst not

containing so much as the matrix, has present a percentage increasing with the Si-content of the alloy. (2) The Mn is largely found in the carbide to the exclusion of the Si. (3) The sulphur appears to cause the exclusion of the Si from the carbide, but the methods employed failed to reveal the presence of any quantity of S in that constituent. (4) The heat-treatment experiments indicate that the presence of these elements, by modifying the composition of the carbide, renders it more or less difficult to dissociate at a given temperature. By altering the composition of the alloy, the solubility of the carbide in the austenite was modified, and therefore more or less free carbide was subjected to the conditions of dissociation. It is also shown that the space occupied by, and the structure of the free "annealing" carbon nodules are determined by the size and structure of the free carbide from which they are produced. The precipitation of free carbon during cementation is discussed, and the phenomenon of "black" steel is considered in the light of the observations made during the research. [See Abstract No. 912 (1907).] C. O. B.

971. *Influence of the Electrolyte on the Maximum Tension of Electrolytic Valve Cells.* **G. Schulze.** (Ann. d. Physik, 34. 4. pp. 657–710, April 7, 1911. Communication from the Physikal.-Techn. Reichsanstalt.)—The author uses Ta anodes for his comparisons, because they show the valve effect in all electrolytes with the exception of hydrofluoric acid. The formation curve of Ta and also of other metals shows two points of inflection; the first marks the beginning of a spark discharge, while the rise in the tension continues at a diminished rate; at the second, more pronounced point, the sparks become more noisy, and the rise of tension ceases. The first point seems essentially to depend upon the anode metal, the second on the electrolyte. Tantalum always reaches its max. tension; in Al, Bi, Sb a real and an apparent lower max. tension must be distinguished; the latter is observed in electrolytes in which the metal is noticeably soluble. The real max. tension is about the same for the four metals. The max. tension of Al is in diluted sulphuric acid 20 volts, in fuming acid 425 volts; as the solubility of the Al in sulphuric acid decreases with rising concentration, the apparent max. tension approaches the real maximum. As regards Ta anodes and various anions, the max. tension depends upon the equivalent concentration of the free anions (not on the total concentration of the electrolyte). There is for every metal in the anion a characteristic specific max. tension, almost independent of the anion, and in this respect the metals may be arranged in a series which begins with Pd (20 volts) and ends with Al (660 volts). The author refers his specific tension to an anion-concentration of 0·05 N. The specific tensions of anions which do not contain metals lie, on the whole, higher between the limits 440 and 500 volts, and anions containing N, S, C, give similar curves. With increasing concentration the specific tension decreases, fairly at the same rate for all electrolytes (by 0·24 per cent. when the concentration increases by 1 per cent., within the range 0·05 to 0·5 N). Metals which produce low-tension values as anions do this likewise as kathions of a non-dissociated molecule; Fe, for instance, both in the anion $Fe(C_2O_4)_3'''$ and in the molecule $Fe^{\cdot\cdot}(HCOO)_2''$. The free kathion does not affect the max. tension. H. B.

972. *Rapid Determination of Nickel and Cobalt by means of the Gauze Kathode and Stationary Anode.* **R. C. Benner** and **W. H. Ross.** (Amer. Chem. Soc., Journ. 33. pp. 493–504, April, 1911.)—[See Abstracts Nos. 1820 (1909), 180 and 560 (1911).] The rapid determination of Ni by means of the gauze electrode and stationary anode can be carried out successfully, using the following electrolytes: (1) Ammonium sulphate and ammonium hydroxide, (2) ammonium acetate and ammonium hydroxide, (3) sodium acetate containing free acetic acid, (4) ammonium formate in ammoniacal solution, (5) sodium formate in both acid and alkaline solution, (6) ammonium carbonate and ammonium hydroxide, (7) ammonium oxalate either in neutral solution or acid with a mineral acid or alkaline with ammonium hydroxide, the last solution giving the best results. A tendency to form anodic deposits with with any of the electrolytes used could be obviated by the addition of enough ammonia or of glycerol mixture (5 c.cm. glycerol, 45 c.cm. alcohol, and 50 c.cm. water). The same electrolytes could be used for cobalt, with the exception of (7), which gave low results. A cyanide electrolyte gave bad results with both metals. The currents used varied from 3 to 4 amps., the smallest kathode used being 3·5 cm. high by 2·5 cm. in diam., and made of Pt-wire 0·1 mm. in diam. with 26 meshes to the sq. cm. The rate at which deposition takes place is practically the same for all the electrolytes which can be used in ammoniacal solution, and is little affected by the amount of ammonia added; it is not quite as rapid as when the electrolyte is mechanically stirred. In acid solution the rate of deposition is not quite as great as in ammoniacal solution, and decreases slightly as the amount of acid is increased.

T. S. P.

973. *Influence of the Addition of Cane-sugar on the Accuracy of the Copper Voltameter.* **L. Dede.** (Zeitschr. Elektrochem. 17. pp. 238–239, March 15, 1911.)—The author finds that the addition of cane-sugar to the solution used in a copper voltameter makes the latter accurate for current densities as low as $0{\cdot}095 \times 10^{-3}$ amp./cm.^{2}. The electrolyte used in the voltameter was made up of 10 gm. of copper sulphate and 15 gm. of cane-sugar in 100 c.cm. of distilled water. Comparison determinations with a silver voltameter in series gave a percentage difference between the weight of copper deposited and that calculated from the amount of silver deposited, varying from $-0{\cdot}108$ to $+0{\cdot}026$ per cent., the current density at the kathode varying from $0{\cdot}09 \times 10^{-3}$ to $20{\cdot}00 \times 10^{-3}$ amp./cm.^{2}. The differences observed vary irregularly and do not depend on the current density.

T. S. P.

REFERENCES.

974. *Direct Action of Radium on Ammonia.* **E. P. Perman.** (Chem. Soc., Journ. 99. pp. 132–135, Feb., 1911.)—The author finds that 5 mgm. of $RaBr_2$ decomposes about 0·01 mgm. of ammonia per day. [See Abstracts Nos. 1812 (1908), 1013 (1910).]

E. M.

975. *Variation in the Vapour Pressure of a Liquid at Constant Temperature.* **F. Michaud.** (Comptes Rendus, 152. pp. 849–851, March 27, 1911.)—The sole cause of the change in vapour pressure of a liquid at constant temperature is the variation of the pressure on the liquid, no matter whether this variation in pressure is produced mechanically or by surface tension or by osmotic pressure.

A. F.

976. *Separation of Oxygen by Cold.* **J. J. Smith.** (Metallurgical and Chem. Engin. 9, pp. 174–175, April, 1911.)—The author criticises Swinburne's statement that the mixture of two gases involves an increase of entropy [compare Abstract No. 689 (1911)], and objects also that, according to L. Marchis and his own inquiries, the Société L'Air Liquide require only 1/400 of the power which Swinburne demands for the production of oxygen.

H. B.